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Editorial Contents for April, 1929

Volume 103 *No. 4*

Balancing and Dynamic Loading of Locomotives ..... Page 185

Abstract of a paper presented by Dr. R. Eksergian at the 1928 annual meeting the American Society of Mechanical Engineers, in which the author discusses the cross-balancing of main drivers and allowable axle loadings.

C. & N. W. Freight-Car Repair Facilities at Proviso ..... Page 193

The Chicago & North Western operates a large freight terminal, transfer house and classification yards at Proviso, Ill., 13 miles west of Chicago. This article describes the system of handling repairs to freight cars going through that point.

Spring Plant of the New Haven at Readville Shops ..... Page 203

A modern spring shop, which has recently been placed in operation, and is designed to handle all of the spring repair and manufacture for the entire N. Y., N. H. & H. System.

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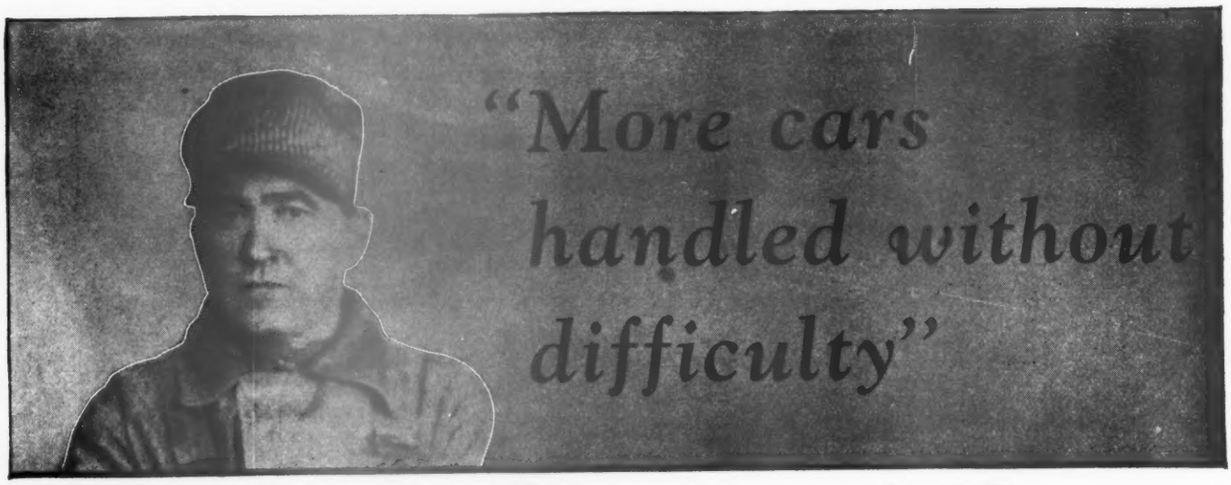

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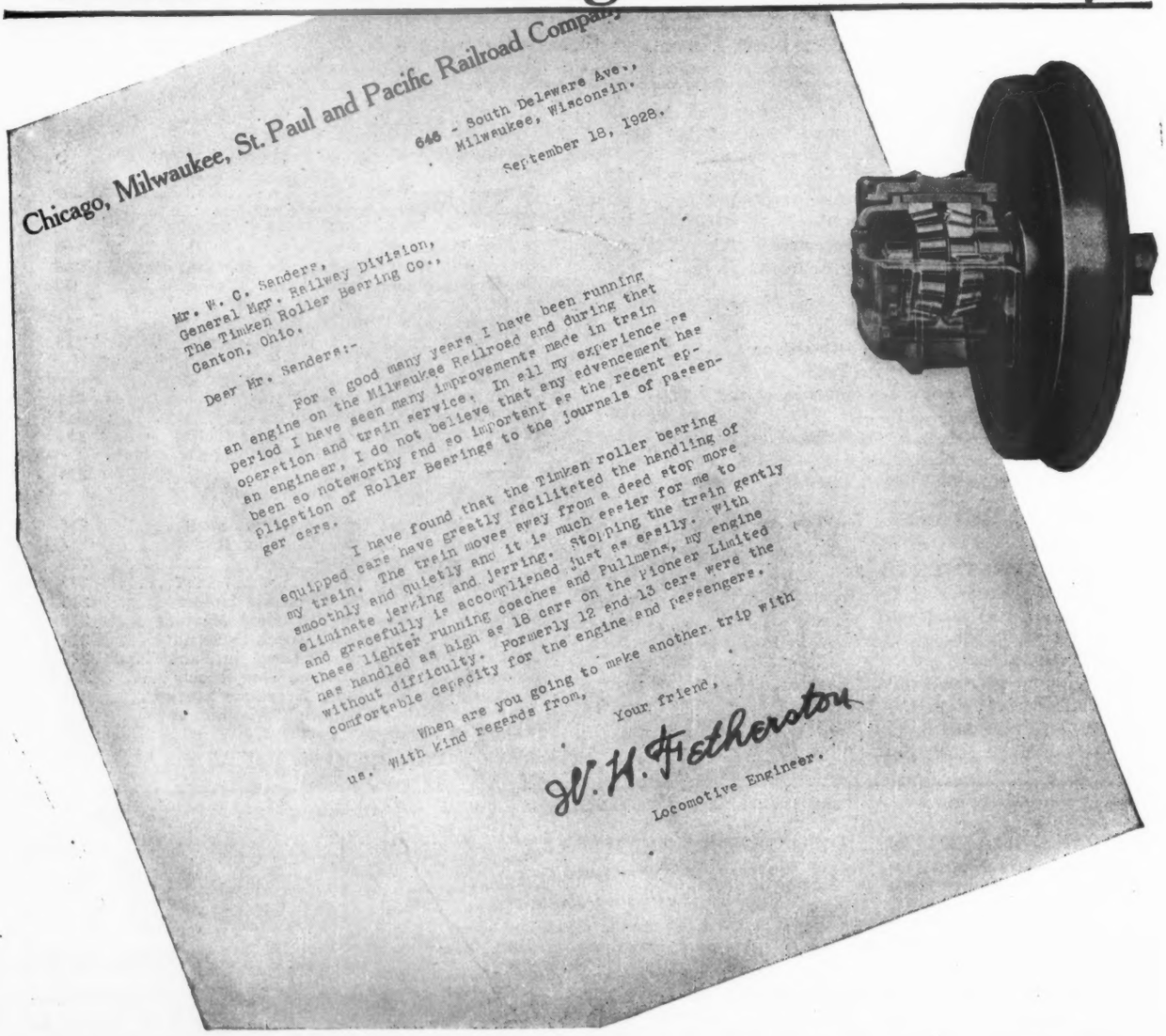

Chicago, Milwaukee, St. Paul and Pacific Railroad Company

646 - South Delaware Ave.,
Milwaukee, Wisconsin.

September 18, 1928.

Mr. W. C. Sanders,
General Mgr. Railway Division,
The Timken Roller Bearing Co.,
Canton, Ohio.

Dear Mr. Sanders:-

For a good many years I have been running an engine on the Milwaukee Railroad and during that period I have seen many improvements made in train operation and train service. In all my experience as an engineer, I do not believe that any advancement has been so noteworthy and so important as the recent application of Roller Bearings to the journals of passenger cars.

I have found that the Timken roller bearing equipped cars have greatly facilitated the handling of my train. The train moves away from a dead stop more smoothly and quietly and it is much easier for me to eliminate jerking and jarring. Stopping the train gently and gracefully is accomplished just as easily. With these lighter running coaches and Pullmens, my engine has handled as high as 18 cars on the Pioneer Limited without difficulty. Formerly 12 and 13 cars were the comfortable capacity for the engine and passengers.

When are you going to make another trip with us. With kind regards from,

Your friend,

W. H. Fetherston

Locomotive Engineer.

TIMKEN *Tapered Roller* BEARINGS

Railway Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

Vol. 103 April, 1929 No. 4

Reading for Apprentices

SOME sort of library seems to be a necessary adjunct to an apprentice school. In some places it is more or less of a modest affair, not always carefully arranged or well kept. In other places the books are methodically arranged and kept in closed book cases. In practically every instance, however, an examination indicates that the books are largely intended for reference purposes in connection with the school or shop work; indeed, in many instances they are highly technical and apparently some of them are only consulted as a very last resort. That apprentice supervisors and instructors have not been entirely satisfied with this sort of library is indicated by questions and comments which have been received by the *Railway Mechanical Engineer*.

Then, too, in recent years has come the realization on the part of many officers and supervisors that the average railroad employee is almost entirely ignorant of the importance of the railroads in the economic and social structure of the nation. Railway employees can well afford to take a real pride in their organizations, because of what the railroads have meant in the development and upbuilding of the country and what they now mean in the continued progress which is being made towards higher levels and better standards of living. What would it not mean if the younger men who are entering the railroad organization could early gain an adequate conception of the importance of the railways in these respects?

F. E. Lyford, who for several years headed up the apprentice work on the Lehigh Valley has been instrumental in developing a new type of library for the apprentices at the Sayre, Pa., shops. It includes railroad books of a general nature, the reading of which will broaden the boy's background and give him some conception of the importance and value of the railroads, although some of the books may be tinged with a spirit of romance and be easy to read, even for the boy whose taste in that direction has not been cultivated.

It must be kept in mind that the books in this library, as described by Mr. Lyford elsewhere in this issue, do not by any means cover the field, even in a general way. The list is restricted to keep within a modest financial requirement. The idea has apparently appealed to the boys. They are contributing to a library fund and are interested in the enlargement of the library.

The Lehigh Valley experiment would seem to offer great possibilities and doubtless other apprentice schools will be inspired to follow its lead in principle, even though they may not entirely agree with the particular books which have been selected. It is to be hoped, also, that some of the railway officers or supervisors will be able to dig up and present to such libraries copies of Jim Skeevers' Object Lessons, by John A. Hill. Unfortunately this good book is now out of print, but it should prove a real inspiration to the young men. Books such as this, which have proved to be a help to men of an earlier generation, may possess a real value at this time and can be put to good work, if they can be rescued from private bookcases and continue their good work with the present generation. The *Railway Mechanical Engineer* will be glad to receive comments or suggestions as to interesting and valuable books for apprentices which may not be included in Mr. Lyford's lists.

The Future of the Smith Shop

IF one is to accept literally statements that have been made by some old-timers among the railroad master blacksmiths, the day of the railroad blacksmith shop is rapidly drawing to a close. There may be those who believe this to be true, but their opinion is not shared by an increasing number of blacksmith shop supervisors who are looking into the future with a confidence that new methods and new materials are about to broaden their opportunities to make the modern forge and spring shop a vastly more important factor in the maintenance of motive power than it has ever been in the past. To the man who looks upon the railroad smith shop as a place where iron is worked, the future holds little in prospect, but to the man who sees the future in terms of steel, the opportunities are limitless.

It has taken a long time to convince some men that the modern forge shop requires a new type of supervisor. He may be either a young man with experience in handling steel gained as a result of contacts outside the railroad field, or, as in one of two instances that have come to our attention, a man with years of railroad experience who has refused to allow himself to become old in his ideas. Such a man, with more than forty-five years' railroad experience, recently told a member of this staff that the future of the railroad master blacksmith depends upon whether or not he is willing to accept the fact that modern steels cannot be handled by iron shop methods and to take the steps necessary to obtain the information he must have to

process these materials without fear of their failure in service.

This means that the modern forge-shop supervisor must go outside of the railroad field to obtain the education he needs to meet the responsibilities of the future if for no better reason than that it is not possible through any existing railroad organization to obtain such an education from other railroad men.

The *Railway Mechanical Engineer* has previously suggested the advisability of such a course. At this time the opinion is offered that the progressive forge shop foreman owes it to himself and to his company to become associated with the work that is being carried on by the American Society for Steel Treating, the entire activities of which are devoted to improved methods of handling modern steel.

More Work for the Air Brake Association

THE work done by the Air Brake Association since its first convention in Columbus, Ohio, in 1894, has been a powerful influence toward obtaining improved train-brake operation and maintenance. The importance of its work has attracted a large membership of air brake men from practically every railroad in the United States and Canada, as well as in Mexico and several other countries. There has been a steady increase in attendance at its annual conventions. This increase in attendance has been accompanied by a corresponding improvement in the quality of the reports and papers and in the character of the exhibits.

The tentative program for this year, which is published in the news section of this issue, contains a number of timely and important subjects. One of these subjects is the committee report on main reservoirs which is continued from last year. The Committee on Main Reservoirs has made an exhaustive study of ways and methods to eliminate corrosion and has gone into the subject of design, location of drain cocks, materials and protective coatings very thoroughly. The report to be presented this year will, in all probability, be the final report of this committee. Its conclusions and recommendations, together with the ensuing discussion, should be of interest and value to all air brake men.

New developments in railroad appliances and equipment, in which operation by compressed air plays an important part, have increased the work and responsibility of air brake foremen and supervisors. In addition, the maintenance of many appliances that do not operate by compressed air, such as injectors and steam-heat equipment, has been turned over to the air brake department, simply because that department is better adapted to perform such work. Many railroads maintain air compressors, feedwater pumps, and power reverse gears in one department, and with the same force.

The two papers pertaining to air brakes on motor-rail cars and the papers on automatic train control and car retarders which are on the program for the coming convention at Chicago indicate that this trend in the work of the air brake foremen and supervisors is recognized by the Air Brake Association. Last year the association included in its program a paper on air brakes for motor trucks and buses. At the present time the possibility of the railway air brake department being required to maintain equipment of this character appears to be somewhat remote. The same may be said with respect to the electro-pneumatic car-retarder equipment.

In order to cover the field in which its members are immediately interested, the Air Brake Association should include in its programs papers on the maintenance of auxiliary equipment and appliances, such as injectors, lubricators, feedwater pumps, power reverse gears, etc.

The Question of Free Service

NOT so long ago a supervisor of machine tools and shop equipment was heard to complain about the high price of machine tools. He did not fully realize that he was partly responsible for the prices to which he objected. At a recent meeting of machinery manufacturers the question of how much engineering service it is good business to give in advance of a sale was discussed, and the following actual experience was referred to: An inquiry for equipment, the total price of which approximated $7,500, included so many requests for information and proposed layouts that it cost one of the bidders nearly $500 to submit his quotation. Complete time studies and considerable drafting-room work were required and, after the prospective customer was furnished with all the desired information, a competitor received the order.

Five or six other manufacturers were asked to quote on the same equipment and, presumably, each had to incur approximately the same expense, so probably about $3,000 was spent for engineering service by all the bidders in their efforts to obtain a $7,500 order. Considering the whole proposition, this sale was made at a loss to the industry, yet the buyer expressed his opinion that the price of the equipment was rather high.

Machine-tool manufacturers are willing to render liberal service to their customers, but they do not believe in wasteful service which some railroads are fostering by their practices in purchasing machine tools. Some railroads when entering the market for a certain type of tool request many builders to submit bids, which may be followed by one or more visits of a sales engineer, from each builder. He will secure all of the data possible and then have the engineering department of his company prepare time studies, tool layouts, etc., all of which costs money and which must be included in the price of the machine. If this practice does not add materially to the prices of machine tools, then the manufacturers are operating on a basis which is leading straight toward bankruptcy. In that case, it is only a question of time until the present buyers' market will be changed to sellers' market, at which time the railroads will have to pay whatever prices the builders choose to set for their products. In either case, the practice illustrated does not benefit the purchaser and is wasteful because it is unnecessary.

In asking for bids on machine tools it is seldom necessary to include the names of more than two or three manufacturers of each tool since it should be, and on many roads is, the function of the using department to eliminate from consideration all manufacturers whose tools, for one reason or another, will not meet the technical requirements. With a list which is limited to legitimate prospects before proposals are requested, much of the waste will be eliminated and the cost of sales engineering services reduced to something like a

reasonable proportion of the amount involved in the sale.

If a railroad still feels the need for a vast amount of engineering service prior to the purchase of a machine tool, a reasonable estimate of the cost of this service should be deducted from the price finally paid for the tool and the fairness of the remainder, as a price for the tool alone, considered before any complaints as to price are offered.

Appearances Sometimes Deceptive

RECENT years have witnessed a most distinct improvement in employees' magazines, several of which have been in existence for many years; moreover, the number of these magazines has steadily grown until there are now about fifty of them, ranging all the way from large, well-illustrated magazines, to elaborate and pretentious bulletins. The editors of these magazines have a difficult problem. They must understand the technique and ethics of editorial work and at the same time must set up proper safeguards, so that when they touch in any way upon technical subjects it will be done in an intelligent and constructive manner. The mechanical department in many of its aspects is highly technical, and that department also has a large percentage of the employees who are reached by these magazines. The editors, in order to compete with other classes of magazines for attention, wisely make use of many illustrations and brighten up their publications in every way possible, in some cases even going to the use of special paper and ink.

One danger is that in attempting to improve the artistic appearance of the paper, offense may be given, or the magazine may be placed in a ridiculous light in the eyes of some of those who are making every possible effort to put over constructive programs in their departments, if great care is not exercised in checking the accuracy and suitability of the material. For instance, in the eyes of an artist, a locomotive is a far more live and active agent when a lot of smoke and steam are in evidence as it appears to be rushing along the track. On the other hand, these things are distinct signs of waste and inefficiency to the mechanical and operating men who are fighting hard to reduce fuel costs and secure maximum efficiency in maintenance and operation. Too frequently the practical railroad man is offended by presentations of this sort, when the editors intended only to please.

Again, to most engineers and railroad officers, a modern, giant locomotive is a thing of beauty, because of its great power and capacity, and its ease of operation. The artist in searching for a locomotive, the lines of which may be most pleasing from his point of view, might prefer one of the older types, which are fast becoming obsolete because of their inability to get heavy trainloads over the road or to operate efficiently and economically.

One of the employees' magazines recently jarred the sensibilities of the shop forces by presenting an artistic view of what purported to be a modern machine tool of unusual efficiency. The tool which was pictured was built some time in the 1860's, and according to the standards of modern shop practice should have been relegated to the scrap heap years ago. Imagine the feelings, if you will, of a machine tool manufacturer when he saw this old machine played up in a prominent position in the employees' magazine, when he realized that in the same shop there were several units of his own product which are quite generally agreed to be among the most modern tools of the type illustrated.

These comments are not intended in any way to belittle the efforts of the editors of the employees' magazines or to criticize them. These men are doing a splendid piece of work in a large way and are entitled to much commendation. Rather do we bespeak a closer co-operation between the mechanical departments and the editors of these magazines. It ought not to be a difficult matter for someone in the mechanical department to act as an adviser to the editors on the use of photographs and articles which may concern the activities of that department.

Is There a Future with the Railroads?

THE motive power and rolling stock departments of many railroads in America are passing through a transition period, the effects of which have been felt rather severely by the supervisory personnel for the past year-and-a-half. The spread of the long engine run has been reducing the number of engine terminals which have to be manned and operated and is curtailing the extent of the operations at others which are still in service. Along with this tendency toward the concentration of servicing and running repairs at fewer engine terminals, there has been a marked tendency to discontinue the operation of many of the smaller divisional shops, where formerly a few locomotives received classified repairs, and to concentrate this work at the one or more large system repair shops.

Analogous changes have also been taking place in the case of freight-car repairs. As the result of system surveys, many railroads have relocated freight-car repair facilities at a relatively small number of shop points, in some cases specializing the work at each shop point to cover one specific type of equipment. This has resulted in reducing or abolishing the forces formerly maintained at numerous scattered locations where a relatively small volume of work was turned out.

These changes all augur well for the future efficiency of equipment maintenance. They permit the railroads to provide and take the fullest possible advantage of better facilities at the few large repair points and they permit a higher degree of specialization and systematization in the organization of repair operations.

Unfortunately, however, transition periods are bound to work hardships on individuals, no matter how salutary the ultimate result may be to an industry as a whole. Many foremen have seen their jobs abolished. It is also unfortunate—and in this case for the railroads, as well as for individuals in the organization—that the misfortune of those supervisors who have been set back in the ranks has exerted a marked effect on the morale of those left to carry on the reorganized operations. In some localities, particularly in the southeastern section of the United States, the tendency of such changes to lower the morale of the supervisors has been increased

by a falling off in traffic which has forced severe curtailments of equipment-maintenance activities.

These conditions are leading many mechanical department supervisors to ask themselves in all seriousness: "Is there a future with the railroads?", and it must be said that many of them are reaching the conclusion that the answer is "No."

This answer is not the result alone of the depressing influence of present conditions within the mechanical department. It is in part based on observations of such conditions as the loss of passenger traffic to the privately-owned automobile and motor bus and to a belief that something similar in kind, if not in degree, is being, or will be, experienced with respect to freight traffic. It is influenced by the recent widespread developments in commercial air transport, the romantic appeal of which is filling the public mind. It is influenced by the attention being given by politicians to the development of inland waterways. In other words, there is a tendency to lose faith in the entire business of rail transportation.

It is not our purpose to attempt to laugh away the effect of these depressing factors in the situation, but to inquire whether there may not be high lights in the picture which are as worthy of attention as the shadows.

The entire transportation industry is passing through a transition period somewhat akin to that through which the mechanical department is passing. It has now become evident to the most skeptical that the railroads must share commercial transport with the motorized highways and the air. They may, in certain localities, have to share it with local waterways if sectional interests can succeed in getting the nation to finance their waterways for them, which as yet is by no means certain. Admitting the painful character of the transition process, however, and the most sanguine hopes of the adherents of the other facilities, the steam railroad still looms up as the one great transportation medium, without which America's material civilization would collapse, and the one on which it will have to depend indefinitely for the movement of the great bulk of its commodities, and for the bulk of its long distance passenger travel as well. Transportation by rail will long remain one of the great basic industries.

It has frequently been pointed out that, with rates rigidly controlled by public regulation, the future health and prosperity of the railroads depends upon their ability to reduce expenses. For many years the railroads have been reducing expenses by increasing train loads and in other ways improving the efficiency of freight-train service. This they are continuing to do, but they are not stopping there. The very fact that marked changes in the organization and methods of maintaining cars and locomotives are taking place is evidence that there is still great vitality and initiative in the industry.

What does this suggest as to the future with the railroads? Not much, it is true, to the foreman who sees nothing in his job beyond conducting the routine of operations and methods as he finds them. But to the man who thinks of himself as bigger than his job and who finds satisfaction in the exercise of all of his faculties—his ability to organize and to lead, his ingenuity to develop improved methods and practices, and his skill and initiative in getting his ideas into practice—the opportunities are probably greater now than ever before. The day is past when precedent in the conduct of any of the widely ramifying operations of railroading is sacred. Efficiency in all its operations is a necessity of the industry.

Railroading has never offered men soft jobs. In that respect it is no different now than it ever has been. There will be a difference in the future, however, particularly in the mechanical department, in the kind of problems to be solved. In a former day the criterion of the success of a foreman was his ability to get work done without facilities; in other words, his ability to produce "bricks without straw". It mattered little whether or not the result was efficiently obtained so long as it was obtained.

The supervisor of the future will be judged by his ability to find and secure facilities and to develop methods whereby he can cut his costs. Indications are that the opportunities for reducing costs without the expenditure of capital are fast being discounted. The problems of present and future supervisors are problems of specialization and systematization, in the solution of which the use of highly developed and specialized facilities will be of constantly growing importance. The romance of the old-time rough-and-ready railroading is passing, but to the type of supervisor who is willing to swap the "grandstand" appeal of romance for the opportunity to utilize every faculty of his mind and his personality, in a business than which there can be none more essential, there is now and long will be a future with the railroads.

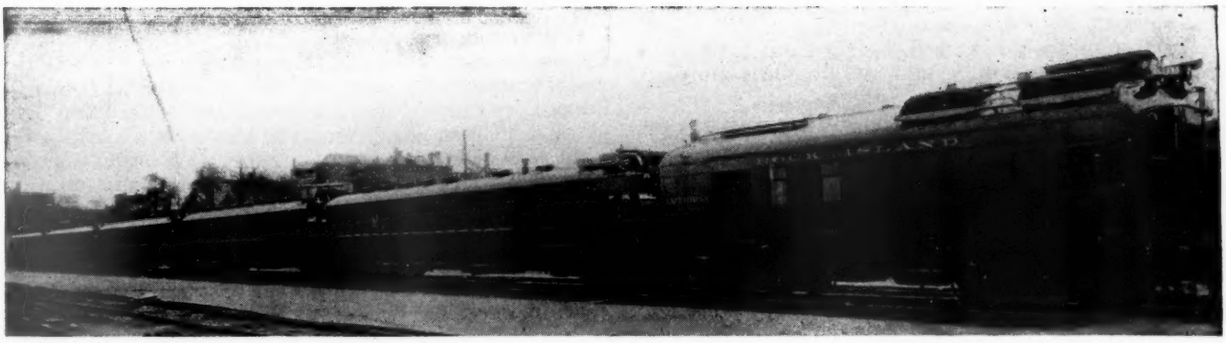
New Books

THIRTEENTH ANNUAL REPORT OF THE ENGINEERING FOUNDATION. *Thirty-six pages illustrated, 7 in. by 10 in. Published by the Engineering Foundation, Engineering Societies building, 29 West Thirty-Ninth street, New York.*

This is the annual report for the thirteenth year of activity of the Engineering Foundation which functions under the joint auspices of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers. It contains a resume of the origin and function of the Engineering Foundation, a review of the year's activities, a list of the members of the Foundation, a brief outline of the various projects which the Foundation is sponsoring and a list of the fifteen publications that have been published during the past thirteen years.

THE ENGINEERING INDEX, 1927, *898 pages, 6¾ in. by 9½ in. Price $8.50, to A. S. M. E. members $7.50. Published by The American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York.*

The Engineering Index is a familiar volume to all those who are connected with any of the engineering professions. It has been published since 1884. With this volume, however, the American Society of Mechanical Engineers brings to a close another period in the history of the Index. The system which has been used in previous years, of indexing only the most important articles in somewhat limited fields of engineering, was discarded with the inauguration, the first of this year, of the Society's new weekly card index service. This new service involves the reviewing of a larger number of publications from which will be indexed a greater percentage of material. It is expected that approximately three times as many items as heretofore will be prepared. Future annual volumes of the Index, therefore, will be decidedly larger in size.



Fleet of gas-electric rail motor cars placed in service on the Rock Island Lines in 1927

Rail Motor Design and Maintenance*

Some pertinent comments on these two vital phases of motorized rail equipment

By E. Wanamaker
Electrical Engineer, Chicago, Rock Island & Pacific, Chicago

THE questions of rail-motor engine design, fuel, lubricants, reclamation of lubricant, etc., are all closely interwoven and more or less interdependent. It therefore is desirable that all concerned make thorough studies, complete in every detail, before buying motorized rail equipment. Otherwise they will fail to secure that equipment which will render the greatest net economy, giving due consideration to the first cost and the allied fixed charges, cost of maintenance, cost of operation, and the reliability of the equipment, assigning a definite value to the equipment, so that the proper charges can be made for the loss occasioned on the day when the equipment is inoperative or unavailable for service. There is also the obsolescence feature to be considered, which at this time is a most important factor in view of the rapid developments and improvements that are being made.

The electrical equipment is more nearly standardized than the engine equipment, but even so, a careful study of such equipment should be made prior to its purchase, both as to reliability and efficiency, and it might be well to bear in mind that reliability is the prime factor and generally a small percentage of efficiency can be sacrificed to increase the necessary factor of reliability.

The method of control is also an important factor and should be carefully considered both from an operating and maintenance standpoint, at the same time bearing in mind that the equipment has to be operated in practically all cases by men who have spent their lives in becoming efficient operators of steam locomotives, and maintained by forces trained in the maintenance of steam equipment.

It might also be well to bear in mind that the power plant, including, the engine, electric transmission and control, together with the necessary appurtenances and accessories, including cooling system, are the heart and lungs of a rail motor, and are therefore of the most vital importance and should receive the utmost and careful consideration by those competent to judge the qualities and advantages as well as the weaknesses and disadvantages of the various equipments offered to the purchaser.

It is not only necessary that the individual or component parts of the rail motor as a whole be properly designed and built, but also that they be properly coordinated, one with the other.

The internal combustion engine is the most vital, and at the same time, the most difficult part of the equipment to design, build and maintain. To begin with, the crank shaft must be of sufficient strength and its bearings of ample capacity to operate successfully under all operating conditions and loads that may be imposed upon it, which are within the rated capacity of the engine. As a matter of fact, designers are prone to skimp this most vital part of the engine. The designers are also prone to skimp on the strength of the connecting rod and the capacity of the connecting-rod and wrist-pin bearings. The writer's personal opinion is that it would cost comparatively little more to increase the strength and capacity of these most vital parts. Such strengthening would not only reduce the liability to failure, but would very materially reduce the cost of maintenance.

Generally the engine frames, or what are commonly known as the upper- and lower-half crank-case sections, are of sufficient strength for the duty for which they were designed; likewise, the cylinder blocks and sleeves where used. However, when we come to the heads, every effort of the designer should be enlisted to produce heads of such design as will permit them to withstand the tremendous loads and strains that are placed upon them in heavy duty rail service. The valve-operating mechanism should be ample and of a rugged design such as will insure permanent adjustment and free operation of the valves. The design should be such that no difficulty will be experienced in making the nec-

* Abstract of two sections of a paper on Rail Motors presented before the March meeting of the Western Railway Club.

essarily frequent periodic inspections and adjustments if the engine is to operate efficiently.

The pistons should be well designed for the service they are called upon to render and, at the same time, as light as is compatible with strength and safety.

The lubrication system of an internal combustion engine, especially in rail service where the cooling facilities are limited, has an extremely important and most difficult duty to perform. Some designers favor a dry crank case sump lubricating system; that is, one employing a tank located separately from the engine and connected thereto by pipe, this tank containing a strainer or filter and acting as the oil storage reservoir for the engine lubricating system—the oil being pumped from the tank to the engine parts to be lubricated and the oil draining to the crank case sump where it is picked up by a scavenger pump and returned to the storage tank and filter, preferably through an oil cooler.

Some designers seem to favor storing the oil in the lower tank case. In either case the system should have ample capacity for the heavy duty that it has to perform. Likewise, the pumps and piping should be of ample capacity and the workmanship and material should be beyond reproach.

In any lubricating system every facility should be provided to insure ease and accessibility for cleaning and maintaining the oil cleaning or filtering devices. It might be well here to state that the heavier the engine the more essential becomes an oil cooler.

Two Classes of Engines

The engines used so far in rail motors may be divided into two classes, one which carburetes the fuel and one which supplies the fuel to the cylinders by means of a solid injection system. The carbureted engine requires an external ignition system, such ignition system being one of several forms of electrical design. The oil-injection type of engine does not require any external source of ignition since the charge is fired by the heat of compression. In either case the function performed is a most important one.

Carbureted engines may burn either gasoline, distillate or light oil. Whether burning gasoline or distillate fuel, it is essential that the carburetors be kept in 100 per cent normal operating condition at all times, and the simpler and more rugged they can be made, the better for the rail motor. The same holds true with the solid oil-injection devices used on the oil engine.

The function of the ignition system of a carbureted engine is a most important one. The larger the engine, the greater the difficulty in designing a satisfactory ignition system. With an increase in cylinder size, the single spark plug is no longer adequate for the job, and multiple plugs per cylinder are required, and they must function simultaneously. This is only possible with an improved device for supplying the electric current to them. This has been accomplished up to and including two plugs per cylinder, using magnetos, which operation, however, has not been entirely satisfactory. The result has been the development of a battery-ignition system, which has already proved its worth, although there is still plenty of room for improvement. No doubt within the next year or so battery ignition will be standard on many heavy-duty engines.

In a more or less facetious vein the author would like to say that most engine designers and manufacturers, at least insofar as engines for rail motor service are concerned, have been exceedingly guilty in tying on a lot of 10-cent store contraptions to an otherwise well-designed and well-built engine when considering such parts as ignition and carburetion systems.

Cooling System Often Inadequate

One of the weakest features of a rail motor has been the poor design of the cooling system. This probably was occasioned by the fact that until quite recently heavy-duty internal-combustion engines were used only in marine or stationary service where the cooling was a comparatively very simple problem. With the application of heavy-duty engines to rail motor service and to a lesser degree in highway motor-coach service, the problem of engine cooling tremendously increased and it has taken some time for the designers to develop a satisfactory cooling system. However, it is felt that today satisfactory cooling systems are entirely feasible.

A satisfactory cooling system must cool the engine sufficiently in the hottest weather under the heaviest load and at the same time must not be liable to freeze up in the coldest weather under the lightest load. The author's personal opinion is that an automatic temperature control of the cooling water is necessary for the larger units now being applied to rail motors.

The base on which the internal-combustion engine and generator is mounted must be sufficiently rigid to insure permanent alinement of the crank shaft and generator shaft, and the coupling between them should be of such design as to insure freedom from failure and yet sufficiently flexible to take care of any slight misalinement and harmonics in the engine. The generator should be of extremely rugged design, especially as regards the commutator and brush rigging. The insulation should be of extremely high grade to insure against grounds, shorts and flash-overs. The coil insulation should be such as will withstand a very high temperature. Particular attention should be given to the accessibility of brushes, brush rigging and bearings.

The traction motors should be of an extremely rugged design due to the isolated service conditions under which they often operate. They should preferably be of the self-ventilated type rather than the blown type. The bearings should be liberal in size and have an adequate lubricating system, so arranged that oil may be replenished and inspection made without great difficulty. The brushes and brush holders should be of rugged design and accessible for inspection and adjustments through the inspection holes.

The important things in a traction motor are good commutation, freedom from flash-overs, grounds, shorts, and broken bands. Traction-motor leads should preferably be on the axle side to facilitate inspection and maintenance.

The storage batteries of rail motors are an integral part of the power plants and as such should have their duty confined insofar as is possible to generator field excitation and engine starting. They should be of the most rugged and efficient design possible to obtain. They should be housed in such manner as to insure good ventilation, ease of inspection and flushing.

Simple Rugged Control Needed

The control system should be as simple and rugged as it is possible to obtain and have as few relays, contactors, automatic switches and electrical interlocks as possible. The electrical control should be interlocked with the throttle. The operation of the control should be as near like the operation of a steam locomotive as is possible. The control should have incorporated some feature or device to stop the engine in case of failure of the lubricating system.

A great many who have had experience with rail-motor operation are strongly in favor of having a dead-man control feature incorporated in the control in such

manner as to safeguard train operation and protect the power plant equipment without working a hardship on the engineman.

Many designers and operators favor regulated air pressure for delivering fuel to the engine, while others favor an electrically-driven pump and overflow system. There is much to be said on either side as regards safety and reliability of service.

To safeguard train operation there should be not less than two warning-signal horns.

The heating system of a rail motor should be such that the engine room can be kept warm during layover periods. Recent investigation developed that enough attention has not been given to the heating systems. In some cases it has been found that the heating systems had been well designed and installed but did not heat the cars due to insufficient draft for the fire. A special smoke jack was developed to increase the draft, which made the system entirely satisfactory.

The sand boxes should be so designed that they can be filled from the outside of the car and have suitable covers to exclude rain, snow, etc. The sander equipment should preferably be so arranged that sander pipes will be kept free and in condition to start the flow of sand even if it be a little moist.

The engine-room ventilation should be so arranged that the engineman can regulate it, preferably by admission of air through the front end which should force hot air toward the rear of the engine room and out of roof ventilators. Engine exhaust should aid in ventilating the engine room.

The trucks should be of rugged design to insure permanent alinement of wheels. Some provision should be made to permit removing wheels without jacking up the entire truck frame. Removable outside pedestals have been employed for the purpose. This subject is one well worth much study and further development.

For rail motor cars the Post Office Department has developed a specification covering strength of car body, which is well within the limits of good car construction without sacrificing the economy of light weight construction.

Definite Maintenance Organization Required

The following is written to indicate one method of handling motor cars and motor trains at mechanical terminals which should produce good results. There may be other methods as good or better, but in any event this outline will, it is felt, show the necessity for intelligent

Form M.P. 165 1M 6-27 LKG
Gas-Electric
Distillate burning

ROCK ISLAND LINES

Mechanical Department

MOTOR CAR INSTRUCTION AND RECORD

Car No._____ Between_____ and_____ Month of_____

Enter Date, Condition, or Work Done, and Initials of Employe Performing the Work.

Generator, pump shaft, grease twice every week.	Engine oil—change—every.....miles. Remove and clean strainer every Oil change	Fan motor—grease blade end every week. Commutator end fill cup ½ full every month.	Valve tappets—inspect and adjust every week. Set for .020" hot. .022" cold.	Fuel strainers and carburetor nozzles—check and clean every week.	Controller Contactors and Connections—check and clean every week	Oil pipes—check every week.	All Gauges and Instruments—check every week.	Traction Motor Leads Inspect every week.

Check magneto timing, set breakers .020", Fire at 30° advance—Every week.	Inspect and Oil Traction Motor Bearings at least once every week. Allowable limit of wear 3-16".	Magneto, Distributors, Spark Plugs—check and clean Set spark plug gap .020" every week.	Blow out fuel lines and drain fuel tank sumps—every week.	Generator Commutator brushes and holders—Brush tension 1½ to 1¾ lbs. check and clean every two weeks	Exciter Commutator brushes and holders—Brush tension 1½ to 1¾ lbs. check and clean every two weeks	Traction Motors Commutators brushes and holders—Brush tension 8 to 9 lbs.—check and clean every two weeks.	Fan and Compressor Motor Commutators, brushes and holders—Brush tension, fan motor 3 to 4 lbs.—compressor motor 2½ to 3 lbs.—check and clean every two weeks.

Sandbox, Whistle and Bell—check and clean every two weeks.	Water Pump Packing—Inspect and renew if necessary every two weeks.	Radiator—Drain and wash out every week.	Relay Contactors—check and clean every two weeks.	All Wiring Connections—Check for tightness every month.	Throttle and Air Starter check, clean and lubricate every month.	Air Compressor—oil every month.	Air Compressor—Change Oil every two months.
						Speed Indicator Shaft—Remove and grease every 15,000 miles.	Gears lubricate—every 1500 miles.

Remarks:

See Other Side

Monthly record card which has proved effective in promoting better rail motor maintenance on the Rock Island
The reverse side of this form contains a condensed list of operating and maintenance instructions, a list of the spare parts which must be carried and a form for a daily record of battery gravity tests and flushing

and careful maintenance; i. e., that the maintenance be fully familiar with the small details of construction, as well as with the general design and operation of the equipment in their charge for the reason that adjustments, clearances and tolerances of the motorized equipment, and especially the engine and it's accessories, are exceedingly fine and close—just the opposite of those that are used in locomotive and car maintenance—and for the same reason the necessity of preventative main-

tenance is one hundred fold more necessary than it is in the handling of steam equipment.

For example: The timing of the ignition, the valve events, etc., may be off a small percentage of the whole—a percentage that in steam practice would mean perfect operation but in internal-combustion engine practice may easily mean a total failure.

Motor cars may be successfully maintained by following either of two general systems of organization. The choice of the system will depend somewhat upon the number of motor cars in service, their distribution over the railroad and the general policy of the railroad as regards the operation and maintenance of motive power and rolling stock.

The system in use on the Rock Island is primarily a divisional organization. The other is a system in which the bulk of the responsibility is borne by a superintendent or supervisor of motorized equipment located at general headquarters in the operating department, with assistant district and territorial assistants who keep closely in touch with the individual rail motors and the individuals who maintain and operate them.

In the divisional organization there is one man at the general headquarters with or without assistants, depending upon the number of motorized equipments in service, who does not directly follow up the maintenance and operation of the individual motor cars or motor-car power units but who does handle and clear matters having to do with the design, purchase, operation and maintenance of such equipment.

The studies and recommendations regarding the purchase and operation of motorized equipment should preferably be in the hands of a committee from the general offices consisting of representatives from the traffic, transportation and mechanical departments, including the general head of motor car operation, this committee working in connection with the division traffic, transportation and mechanical officers, as well as with the sub-district or district-traffic, transportation and mechanical officers.

At such time as an agreement is reached relative to the recommendations for the use of motorized equipment, the entire matter should be referred to the chief operating officer for handling. In this manner equipment is only purchased after it is definitely known when and how it can be assigned, operated, etc., so as to effect the estimated savings or earnings.

When the equipment is received after having been duly inspected and tested, the design and type having been originally passed on by the responsible heads of all departments concerned, it is delivered to the various runs to which it has been assigned. In case a road is divided into two or more districts, the equipment then comes under the district organization; i. e., general manager, or manager and his staff, and they in turn require the division people to maintain and operate the equipment.

It is generally advisable to have one or more district supervisors, depending upon the number of equipments in service. This supervisor should report to the ranking district mechanical officer, and his duty should be to see that the master mechanics, general foremen and road foremen, who are directly responsible for the maintenance and operation of the motor car equipment, are fully informed and advised.

If there is much equipment involved, it is also advisable to have an expert traveling motor-car mechanic who is capable of doing any of the mechanical work on the power plant equipment so that he may, by working with local maintainers or mechanics, give them an opportunity to become thoroughly familiar with the exact and detailed methods and requirements necessary for properly caring for such equipment. He should also inspect and pass upon all back-shop work.

In general, if this system of organization is followed, the division people soon become familiar with this new type of motive power and are able to maintain and operate it successfully and economically. Also, under this system the local people, as time goes on, become more and more competent and efficient, with the result that the maintenance and operation of such equipment becomes as much a part of the general scheme of railroad operation as the maintenance and operation of the steam locomotive.

Road Foremen Must Be Instructed

The qualifying of road foremen of equipment is a most important and vital factor since, they are the men who must, in turn, qualify and supervise enginemen operating the motorized equipment.

The sub-district or district supervisors and traveling motor-car mechanic should periodically inspect and make a report on each motor car. One copy of the report should go to the division master mechanic, one copy to the local foreman in charge, one to the district superintendent of motive power, and one to the supervisor of motor car equipment and operation in the general office where it is kept on file. In this way all those bearing responsibility for the maintenance and operation of the motorized equipment are kept fully informed as to the existing conditions and requirements.

It is a good idea to have a history or record card for each motor car, containing the most important and vital instructions for the operation and maintenance of the car—the opposite side of the card having designated space for entering the necessary terminal inspections and records of adjustments, etc., as called for on the card. This card should be arranged to take care of a monthly period and at the end of the month be forwarded to the supervisor of motor-car operation in the general office, transferring the last entries from the old card when putting up the new one. In this manner a continual record of the performance of the motor car is available, a study of which will do much to guide those responsible for the design, purchase, maintenance and operation of motorized equipment.

When an engineman takes a motor car or a motor-car power unit out of an engine terminal, unless it happens to be at an isolated point where he, himself, is primarily responsible for the care of the equipment, he is justified in assuming that the car is turned over to him in good operating condition and ready for service. He should, however, assure himself by careful inspection and testing out all such parts as may be necessary that this is true before leaving the terminal and he should also see that all necessary supplies, spare parts and tools are on the car.

If the engineman has been duly qualified, he will have made himself entirely familiar with the equipment which he is to operate, knowing that he is free at all times to ask or seek any information he desires and that such information will be forthcoming. Upon completing a trip the engineman should make out a complete inspection and work report, the form for which should have been worked up especially for motor-car operation.

In case there is any part of the power plant or car not operating as it should, he should also talk to the local foreman or responsible maintainer in charge, endeavoring to give as clear and complete a picture of the

situation as possible, to facilitate making repairs.

When a motor car or motor-car power unit arrives in the mechanical terminal after completing its run and the engineman has completed his inspection and report, the local forces responsible for the maintenance of the equipment should take immediate action to do everything necessary as rapidly as possible to place the equipment in condition to be dispatched on its next trip, since the cost of motor-car equipment is such that it can not be left standing for long periods in the terminal as have our steam locomotives.

Refuel the Motor Cars Promptly

It is generally desirable to fuel a motor car as soon as it comes in off its run if its fueling station is at that end of the run. In this connection and as the motor-car units become larger, it will probably be found desirable for the railroad to install its own fuel stations. In case of distillate and oil-burning engines, this is practically necessary in all cases.

Fuel stations should be carefully installed with such

GAS-ELECTRIC

ROCK ISLAND LINES

MECHANICAL DEPARTMENT

ENGINEMEN'S MOTOR CAR TRIP AND WORK REPORT

Place _____ Date _____ 192__

Motor Car # _____ From _____ To _____

Miles Run _____ Consumed _____ Gals. Gasoline. _____ Gals. Engine Lubricating Oil.

Temperature Cooling Water Max _____ Average _____ Low _____

Main Reservoir Pressure _____ Pounds. Brake Pipe Pressure _____ Pounds.

CONDITION OF EQUIPMENT

	IF O. K. INDICATE WITH CHECK MARK IN THIS COLUMN	REPORT HERE NATURE OF TROUBLE IF ANY	WORK PERFORMED BY
Brake System			
Brake Piston Travel			
Engine			
Generator			
Exciter			
Battery			
Relay Contactors			
Fan Motor			
Compressor Motor			
Traction Motors			
Controller			
Throttle			
Ignition System			
Magnetos			
Cooling System			
Carburetor			
Carburetor Strainer			
Fuel System			
Fuel Pressure Regulator			
Oil System			
Air and Electric Starters			
Sanders, Whistle and Bell			
Gauges and Instruments			
Wiring			
Piping			
Car Body			
Car Trucks			
Car Heating			
Car Lighting			
General Condition			

INDICATE BY X IF REPORTED FOR WORK.
MAKE ANY ADDITIONAL REMARKS ON BACK OF REPORT.
Send 1 copy to Electrical Engineer's Office, Chicago.
Retain 1 copy on Roundhouse file.

_____ Engineman.

_____ Roundhouse Foreman.

Work report which is made out at the end of each trip

storage capacity as to permit purchase and delivery of fuel in tank-car lots. The installation should be so made as to reduce fire hazard to an absolute minimum. All fueling pumps should be metering. Whether they be hand or power-operated will depend entirely on the time available, the cost of labor at the particular point involved, etc. Precaution should be taken to keep water and all foreign matter out of the fuel at all times.

If a crank-case lubricating-oil change is due, the oil should preferably be changed as soon as possible after the car comes in off of its run. Now that the reclaiming of crank-case oil has been proved to be an economic success, the crank-case drainage should be carefully collected for reclaiming in the local plant or for shipment to a district or central reclaiming plant. Every effort should be put forth to save all the drainage in view of its economic value, after the oil has been reclaimed.

In case distillate or kerosene is used for flushing oil tanks or crank cases after same have been drained, this kerosene or distillate should not be put in with the crank-case drainage, since it will increase the cost of reclamation, but should be thrown on the coal pile or used for fire lighting or some other purpose for which it is suitable.

The reclamation of engine lubricating oil is a large subject within itself and it is not within the scope of this paper to go into the value and desirability of the practice except to say that it is an easy way to effect handsome savings.

It is preferable to change the crank-case oil when possible before the motor car is put into a shed or engine house.

Housing Motor Cars

Except in very cold climates it will probably be advantageous in many instances to let motor cars stand outdoors, unless work is to be done which can be better and more easily performed when the car is housed. A careful study and check should be made to determine at what terminals or at what times money can be saved by leaving the car outside, it being borne in mind that many times it is desirable to house the car, not so much for the benefit of the car as for the benefit of the men who are maintaining the equipment. At home terminals, or where suitable housing for motor cars is available without any heavy expenditure for housing facilities, it is in all probability desirable to run motor cars in the house unless they are going out again in a short time.

All open flame lights and fires must be kept away from motor cars at all times, and the pits over which they stand must be kept free and clean of oil, grease, gasoline, etc., otherwise a bad fire hazard will exist. It is a good practice to flush all such pits daily to be sure they are entirely clean and free.

Every precaution should be taken to prevent the accumulation of oily rags, waste or other inflamable material on the cars, in fueling stations, motor-car sheds or engine houses.

In case motor cars are kept in a house containing steam locomotives, it is desirable to keep them as far apart as possible, both on account of fire hazard and for the reason that steam, smoke and gas from the steam locomotive is apt to injure the finish of the motor cars. Where possible a section of the engine house should be blocked off from the rest of the house by a fire wall, thus forming a separate section of the building for motor cars only.

Engine houses and sheds used for housing motor cars should be thoroughly ventilated to prevent the accumulation of inflammable or engine exhaust gases. All motor-car terminals should have an easily available supply of water suitable for engine-cooling system, clear and as free from scale-forming matter as possible.

In case motor cars are kept in a coach yard or yards, every precaution against fire hazards should be taken the same as though they were standing in a shed or house, and it might also be said that the foregoing holds good for freight or switching motorized equipment, as well as for passenger motorized equipment.

When motor-car runs terminate in a large terminal, it is possible to make a quick inspection; also to get such maintenance work as may be necessary quickly performed, since several maintainers are available. In other words, one maintainer will inspect the trucks, car body, safety appliances, interior of the car, etc. At the

same time one or more other maintainers are inspecting the engine, cooling system, control system, generator, traction motors, air brakes, pumps, heating system, etc., and all other parts of the power plant or motor-power equipment, taking such steps as may be necessary to place each part of the motor car and its power plant in safe operating condition with the least possible delay. A check should be made to determine whether or not any of the periodical inspections are necessary. If so, they should be made in accordance with the standard instructions.

The successful operation of motor cars or motor-car power units depends quite largely upon the degree of success with which the mechanical department will be able to maintain them. In other words, the mechanical department has the brunt of the burden to bear in the successful operation of motor cars and motor-car trains.

Did Brown Waste His Time?

In which a sidelight on apprentice training is described

By An Observer

"*MR. BROWN,* what sort of a line or figure does a locomotive crank pin make as the engine moves along a track?" asked a certain railway machinist apprentice of his instructor as the latter stopped at the apprentice's bench during an inspection round.

"Well Jack," answered the instructor, "part of my job is to answer your technical questions, and another part of my work is to teach you to frame your questions in such a way that you can't be misunderstood. Now let's try to analyze your question. Do you mean the figure or line followed by the crank pin with reference to the center line of the axles, or the line of travel of the crank pin with respect to the rail?"

"I guess I mean the line of travel of the crank pin with reference to the rail," answered the apprentice. "I can see that it travels in circles around the center line of the axle all right."

"Good," said Brown, "you've analyzed the problem correctly, so far; and since it would not mean much to you if I told you that the crank pin actually travels through a cycloid as the engine rolls over the rails, I think that you and I had better perform a little experiment to prove it. We'll make this experiment at the noon hour today, if you'll make me a stud like this sketch. We'll use that miniature pair of drivers up in the apprentice room. By the way, Jack, how will you make this stud at a minimum of trouble and expense?"

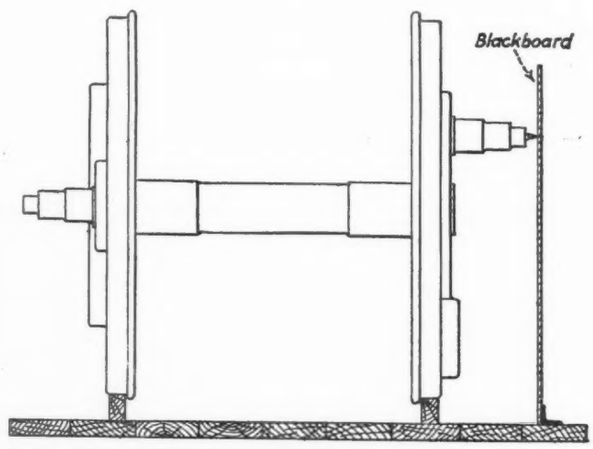
"Oh! I'll get Tommy Hayes, over on that little portable engine lathe, to grab this short bit of ⅜-in. square stock in his chuck and turn it for me to form. That will only take a few minutes of his time and after he gets it formed I'll run some threads on it with a ¼-in. die and have it all ready for you."

"While you're doing that," said Brown, "I'll be drilling and tapping one of the crank pins on the miniature drivers and making a little blackboard to set up beside the rails of the miniature track. Then, by rolling the drivers along the rails with our stud-point just touching the blackboard we will get a demonstration of what actually happens. It's what a college man likes to call a graphic demonstration, Jack."

The experiment was duly performed during the noon hour (with the writer as an interested observer). The apprentices who witnessed this little demonstration came away with about as clear an idea of this form of cycloid as has the average student of analytical geometry.

Now it will probably be argued by many that this whole matter was too abstruse to be of any practical value. In fact, the writer was inclined to this view until the matter had been discussed with the apprentice instructor. This particular apprentice instructor's name is not Brown. While there is no need to conceal his identity, he himself prefers a pseudonym.

"I achieve my modest results in training these boys," he says, "strictly by my own methods and I do not care to be answering a lot of inquiries concerning these methods or to enter into any lengthy defense of them. One rigid policy of my system is that no reasonable technical question from one of my boys shall go unanswered, in so far as I can prevent it. That is why I gave



Perhaps some other boys would like to know what a cycloid looks like. Here is the equipment with which Brown made his demonstration

what you seem to think a rather elaborate demonstration of a matter that will probably have no great practical value to those apprentices.

"However," continued Brown, "I don't have to remind you that in vocational training, as well as in academic training, we have to consider intangible values as well as practical results. I believe that such things as the answering of that boy's abstruse question reflect pretty well in the morale of the whole group; and who is to be the judge of what constructive lines of thought have been set up in that boy's mind, or in the minds of others of the group, by that demonstration? I'll venture that right now some one or another of those boys is trying to analyze the movements of parts of valve gears—say, the blade pins of a Stephenson valve gear. Certainly, such thoughts are about as healthy for them as the plotting of dissipations, or memorizing stale jokes, aren't they?

"Well, the sermon's over and I've got to get back to my rounds. Drop in whenever you get a chance and we'll try to formulate better educational schemes for the bunch that is to step into our shoes and carry on what we have started."

Examples of Recent Locomotives of the 2-8-2 Type

General Dimensions, Weights and Proportions

Railroad	U. S.	U. S.	C. &		A. C.	C. I.	Mo-		Can.	West.	Mo.	C. St. P.	A. T. &	C. R. R.	C. R.	St. L.-		D. L.
Builder	R. A.	R. A.	I. M.	P. M.	& Y.	& L.	nong.	L. & N.	Pac.	Pac.	Pac.	M. & O.	S. F.	of N. J.	I. & P.	S. F.	C. & O.	& W.
Road class	A.,B.&L.	A. & B.	Lima	Amer.	Lima	Amer.	Bald.	Amer.	Can.	Amer.	Amer.	Amer.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.
Road number	Light	Heavy	F-4	MK	R-1	J-3	L-2	J-4	P-2e	MK	....	J-3	4000	. ..	K-64	T-60	K-3a	....
Date built	....	....	550	1041	403	564	183	1863	5367	330	1115	437	4088	919	2683	4155	2320	2148
Tractive force, engine, lb.	1918	1918	1928	1927	1928	1926	1927	1926	1926	1926	1926	1926	1926	1925	1926	1926	1926	1924
Tractive force, booster or aux. loco., lb.	54,600	60,000	54,600	54,800	54,600	63,000	54,700	63,000	57,100	60,300	59,800	63,000	63,000	63,000	63,500	62,950	67,700	67,700
Cylinder horsepower (Cole)	.....	.....	.....	.....	14,400	.....	11,000	.....	.....	10,900	.....	.....	.....	.....	.....	11,200	.....	11,500
Piston speed at 10 m.p.h.	2,434	2,493	2,434	2,434	2,434	2,624	2,434	2,624	2,380	2,683	2,493	2,624	2,624	2,624	2,824	2,634	2,824	2,824
	266.7	284.5	266.7	266.7	266.7	284.5	266.7	284.5	284.5	266.7	284.5	284.5	284.5	284.5	266.7	284.5	284.5	284.5
ENGINE AND TENDER DATA																		
Weight of engine, lb.	290,800	325,000	305,000	311,000	313,800	317,000	318,740	324,000	327,000	330,000	333,000	333,000	337,880	340,510	347,000	349,660	358,000	362,500
Weight on drivers, lb.	221,500	240,000	226,000	230,500	223,300	247,500	236,080	251,500	240,260	247,500	248,500	249,000	249,460	254,010	257,000	266,050	273,500	276,500
Weight on front truck, lb.	20,200	28,000	23,500	24,500	33,500	19,000	21,060	18,500	30,640	25,000	32,000	27,000	33,770	26,490	32,000	21,360	31,000	25,500
Weight on trailing truck, lb.	49,100	57,000	55,500	56,000	57,000	50,500	61,600	54,000	56,100	57,500	52,500	57,000	54,650	60,010	58,000	62,250	53,500	60,500
Weight of tender, loaded, lb.	172,000	172,000	187,100	188,300	197,500	185,000	206,560	193,700	226,300	264,000	195,000	188,900	290,020	209,790	196,000	234,840	298,500	216,500
Tender, water capacity, gal.	10,000	10,000	10,000	10,000	9,500	10,000	12,500	10,000	12,000	15,000	10,000	10,000	15,000	12,000	10,000	11,700	16,000	12,000
Tender, fuel capacity, tons or gal.	16	16	16	16	12	16	16	19	16	4,000	4,000	16	5,000	17	16	17	20	14
Wheel base, driving, ft. and in.	16—9	16—9	16—9	16—9	16—9	16—9	16—9	16—9	16—6	16—6	17—10	16—9	16—6	16—6	17—0	16—9	16—9	17—0
Wheel base, engine, ft. and in.	36—1	36—1	36—11	36—11	36—11	36—1	36—11	36—1	35—8	36—3	37—5	37—7	35—0	37—1	36—2	36—11	37—5	37—4
Wheel base, engine and tender, ft. and in.	71—4½	71—9½	71—8½	71—4½	70—10½	71—8½	71—6½	71—9½	72—1½	73—2½	72—3½	72—3½	79—6⅛	76—8¼	73—0	74—2¼	85—4¼	73—2½
Cylinders, diameter and stroke, in.	26x30	27x32	26x30	26x30	26x30	27x32	26x30	27x32	23x32	28x30	27x32	27x32	27x32	27x32	28x30	27x32	28x32	28x32
Driving wheels, diameter, in.	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
BOILER DATA																		
Steam pressure, lb.	200	190	200	200	200	200	200	200	250	190	190	200	200	200	200	200	200	200
Fuel	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal	Oil	Oil	Soft coal	Oil	Soft coal	Soft coal	Soft coal	Soft coal	Soft coal
Boiler, diameter, first ring, in.	78	86	78	76⅝	78	84½	78	84½	80	82	88	84½	82	86⅞	84¾	86	87	90⅞
Firebox, length, in.	114⅛	120⅛	114⅛	114⅛	114⅛	120⅛	114⅛	120⅛	120⅞	120⅛	114⅛	120⅛	114	126⅛	108½	120⅛	120⅛	120⅛
Firebox, width, in.	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	84¼	108¼	84	84¼	96¼	84¼
Tubes, number and diameter, in.	216—2¼	247—2¼	190—2¼	186—2¼	190—2¼	247—2¼	188—2¼	247—2¼	Note 1	213—2¼	225—2¼	32—3½	244—2¼	247—2¼	189—2¼	214—2¼	248—2¼	300—2
Flues, number and diameter, in.	40—5½	45—5½	45—5½	45—5½	45—5½	45—5½	45—5½	45—5½	45—5½	45—5½	45—5½	200—3½	45—5½	45—5½	48—5½	48—5½	50—5½	50—5⅜
Length over tube sheets, ft. and in.	19—0	19—0	18—0	18—0	18—0	19—0	20—6	19—0	18—0	18—0	19—0	19—0	20—9	19—0	17—8	19—0	19—0	18—0
Grate area, sq. ft.	66.7	70.8	66.7	66.8	66.7	70.3	66.7	70.3	70.3	70.3	66.8	70.3	66.8	94.8	63	70.3	80.3	70.4
Heating surface, firebox, total, sq. ft.	286	319	338	345	338	299	292	299	316	391	360	299	278	357	339	381	338	350
Heating surface, tubes and flues, sq. ft.	3,497	3,978	3,164	3,122	3,164	3,978	3,584	3,978	3,125	3,407	3,727	4,021	4,309	3,978	3,167	3,692	4,120	4,073
Heating surface, total evap., sq. ft.	3,783	4,297	3,502	3,467	3,502	4,277	3,876	4,277	3,435	3,798	4,087	4,320	4,587	4,335	3,506	4,073	4,458	4,423
Superheating surface, sq. ft.	882	993	940	992	940	1,050	1,080	1,050	990	973	1,051	1,977	1,143	994	992	1,126	1,205	1,112
Comb. evap. and super. surface, sq. ft.	4,665	5,290	4,442	4,459	4,442	5,327	4,956	5,327	4,425	4,771	5,138	6,297	5,730	5,329	4,498	5,199	5,663	5,535
PROPORTIONS AND RATIOS																		
Weight on drivers ÷ weight of engine, per cent	76.2	73.9	74.1	74.1	71.2	78.2	74.0	77.7	73.5	75.0	74.7	74.9	74.0	74.7	74.1	76.0	76.4	76.2
Weight on drivers ÷ tractive force	4.00	4.00	4.14	4.20	4.09	3.93	4.32	3.99	4.21	4.10	4.15	3.95	3.96	4.03	4.05	4.22	4.04	4.08
Weight of engine ÷ comb. h. s.	62.3	61.5	68.7	69.7	70.6	59.5	64.4	60.8	73.8	69.2	64.9	53.0	59.0	63.9	77.2	67.2	63.2	65.5
Firebox surface per cent evap. h. s.	7.56	7.42	9.66	9.95	9.66	7.00	7.54	7.00	9.03	10.30	8.80	6.93	6.05	8.23	9.68	9.35	7.58	7.90
Firebox surface ÷ grate area	4.28	4.51	5.07	5.17	5.07	4.25	4.38	4.25	4.41	5.56	5.39	4.25	4.17	3.77	5.38	5.42	4.21	4.97
Superheat. surface per cent comb. h. s.	18.9	18.8	21.2	22.2	21.2	19.7	21.8	19 7	22.4	20.4	20.4	31.4	19.9	18.6	22.0	21.7	21.3	20.1
Tractive force ÷ comb. h. s.	11.70	11.35	12.3	12.3	12.3	11.8	11.0	11 8	12.9	12.6	11.6	10.0	11.0	11.8	14.1	12.1	11.9	12.5
Tractive force × dia. drivers ÷ comb. h. s.	737	715	775	775	775	745	694	7 15	813	797	735	630	693	745	890	762	752	785
Comb. heat. surface ÷ grate area	69.9	74.7	66.6	66.8	66.6	75.8	74.3	75.8	62.8	67.8	75.7	89.5	86.0	56.3	71.5	73.8	70.5	78.7
Notes	b	b	b-d	a-d	b-d-e-g	a	b-d-g-l	a	b-e	a-d-e-g	a-d	a-k	b-e	b-c-e	a-d	b-c-d-g	a-e	a-g

Key to notes: a—Boiler diam., inside; b—Boiler diam., outside; c—Combustion chamber; d—Syphon; e—Feedwater heater; g—Tender booster; k—Type E superheater; l—Exhaust steam injector.

Note 1—Tubes, 32 of 2 in., 158 of 2¼ in.

Suggested Library for a Railroad Apprentice School

The problem is faced from an entirely new angle

By F. E. Lyford
Special Engineer, Lehigh Valley Railroad Company

WHEN a railroad apprentice starts on his time, some effort should be made to show him the broader side of the career he has chosen and also to interest him in its historical record. The railroads of our country have played such a fascinating, romantic part in its development that there need be little fear of having a boy show any lack of interest once he has been properly introduced to railroad literature of the right kind. Realizing, however, that many apprentices are of the type that does not do much reading, it requires some study how best to stimulate the interest that will start the boy on his reading program. The apprentice school library should be a good starting point and it is with that idea in mind that the following suggestions have been made after some thought and study as to what will appeal to and be helpful to boys.

To go back just a little, let it be said that some time ago the *Railway Mechanical Engineer* asked a number of apprentice supervisors as to the contents of their apprentice school libraries. The replies were very similar, since all the libraries consisted practically entirely of reference books, hand-books and text books. The apprentice school with which the author was at that time connected wished to start a library and the *Railway Mechanical Engineer* allowed him to examine these replies and lists. It was at once apparent that the broader type of railroad books had been entirely overlooked. At the suggestion of the editors of the *Railway Mechanical Engineer,* Miss Elizabeth Cullen, reference librarian of the Bureau of Railway Economics, Washington, D. C., was then consulted. Great credit is due Miss Cullen for the complete data that were supplied on books pertaining to railroads that would interest and grip the imagination of the boys and still be very worth while; indeed, it is largely from Miss Cullen's list that the suggested library has been chosen.

In selecting the books for an apprentice library, three divisions have been considered. The first division includes books which contain interesting, exciting narratives of the pre-railroad and early railroad periods, as well as one or two interesting books on railroads in general. Ease of reading, action, romance and interesting presentations of facts have governed the selection, and the books chosen also outline a definite background and should excite a desire for further knowledge of railroad development.

The second division contains those books which are a step ahead of the ones in the first division and go more into the details of the railroads' history. Biographies, histories and greater elaboration of certain periods are covered in this second list.

These two lists make up probably as many books as an average apprentice school can afford and have been kept rather low in number for that reason. The first list can be purchased for about twenty-five dollars, while the second may cost twice that amount.

The third division contains the necessary technical books for reference; the suggested list may be varied according to the experiences and preferences of the school supervisors. These are the books that are probably now on hand in every railroad apprentice school.

Division 1—Introductory Railroad Books

The books of the first division are arranged roughly in a suggested order of reading. The publishers' names are given in all cases to enable the books to be readily located.

The Covered Wagon, by Emerson Hough, published by Grosset & Dunlap.

54-40 or Fight, by Emerson Hough, published by A. L. Burt Company.

The U. P. Trail, by Zane Grey, published by Grosset & Dunlap.

Whispering Smith, by Frank Spearman, published by Grosset & Dunlap.

Across the Plains, by R. L. Stevenson, published by Charles Scribners' Sons.

A Book of Escapes and Hurried Journeys, by John Buchan, published by Houghton, Mifflin Co.

Power, by Arthur Stringer, published by A. L. Burt Company.

I Sing the Pioneer, by Arthur Guiterman, published by E. P. Dutton & Co.

Trains, Tracks and Travel, by T. W. Van Metre, published by Simmons-Boardman Publishing Company.

When Railroads Were New, by C. F. Carter, published by Simmons-Boardman Publishing Company.

The Story of the Railroad, by C. Warman, published by D. Appleton & Co.

Catalog of B. & O. Centenary Exhibition, published by the Baltimore & Ohio Railroad.

Division II—Additional Railroad Books

The second part of this suggested library does not consider the pre-railroad era quite as much as do some of the books in the first division. The great strides that have been made in transportation can be best visioned by reading of transportation just before the coming of the railroads and realizing that up to that time no change had been made in land transportation for thousands of years.

The Way of the West, by Emerson Hough, published by Bobbs-Merrill Company.

American Notes, by Charles Dickens, published by The Macmillan Company.

A Short History of American Railways, by S. Thompson, published by D. Appleton & Co.

E. H. Harriman, by George Kennan, published by Houghton, Mifflin Company.

Life of J. J. Hill, by J. G. Pyle, published by Doubleday, Page & Co.

Commodore Vanderbilt, by A. H. S. Smith, published by Robert McBride & Co.

I Had a Hunch, by A. E. Sullwell and J. R. Crowell, published in the Saturday Evening Post.

Historic Railways, by R. S. Holland, published by Macrae-Smith Company.

The Rise of Rail Power in War and Conquest, by E. H. Pratt, published by J. B. Lippincott Company.

The Anthracite Railroads, by J. I. Bogen, published by Ronald Press Company.

Railroads and Government, by F. H. Dixon, published by Charles Scribner's Sons.

The Modern Railroad, by E. Hungerford, published by A. C. McClurg & Co.

Cassell's Railways of the World, by F. A. Talbot, published by Locomotive Publishing Company, London, England.

The Railway Conquest of the World, by F. A. Talbot, published by W. Heinemann, London, England.

Yale University Chronicles, Volumes 25, 26 and 38, published by Yale University Press.

The Strategy of Great Railroads, by F. H. Spearman, published by Charles Scribner's Sons.

These two lists of books are not to be considered as the last word in books on railroads, but any apprentice boy who reads those of Division I and any three or four of Division II, will surely know more about the history and development of railroads than the average railroad man of today. No effort, of course, has been made to cover the whole field of railroad literature.

Part III—Reference Books

The third part of this suggested library contains the following books for reference purposes only:

Locomotive Cyclopedia
Car Builders' Cyclopedia
American Locomotive Company's Handbook
Baldwin Locomotive Company's Handbook
Kent Mechanical Engineers' Handbook
Machinery's Handbook
Essentials of Electricity, by Timbie
Electricians' Handbook
History of Industry
Brief Railroad History
Simple Economics
} Published by Pennsylvania State College in pamphlet form.
Handbook of Railroad Blacksmithing
Handbook of Railroad Pipe Fitting
Modern Air Brake

It has been found that every boy usually is willing to contribute a small amount towards an apprentice school library fund and there is no doubt but that the books thus purchased will receive good care.

More might be written about the contents of the books, especially those of Division I, but it is almost certain that there is enough action, romance and thrills in these books to satisfy any boy or young man.

Automotive Inspection Car for Canadian Pacific

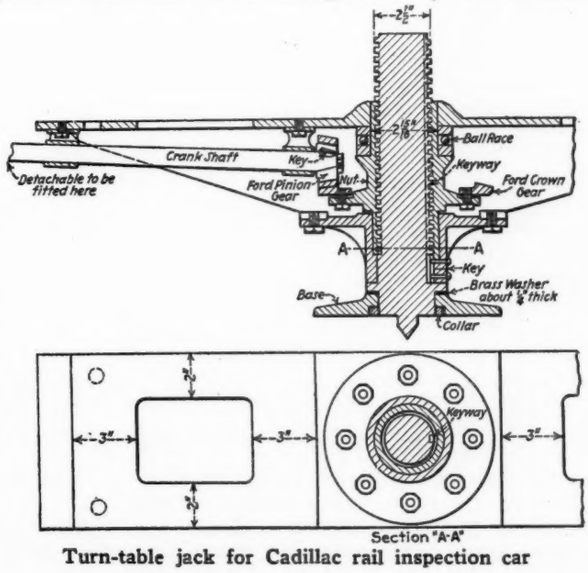
Standard sedan model rebuilt for track service—Carries its own turntable

THE mechanical department of the Canadian Pacific, at the Angus shops, Montreal, Que., recently completed rebuilding a Cadillac seven-passenger sedan for use as a track inspection car. The car, which is used by officers of the engineering department in making long inspection trips on the lines, is said to be capable of operating on the track at a speed of from 60 to 75 m.p.h. with safety.

In order to meet the more severe operating conditions on the track, both standard Cadillac axles were removed from the car. The front axle was replaced by one of more rugged construction, while the rear axle, which was mounted in conjunction with the differential, was replaced by a one-piece axle, twice the size of the original axle. The new rear axle is driven by a single gear and pinion with a ratio of 4 to 1, in place of the Cadillac's standard differential ratio of 4.91 to 1. Both of the new axles are made of heat-treated chrome-nickel steel and rotate with the track wheels.

Axles Rotate on Ball and Roller Bearings

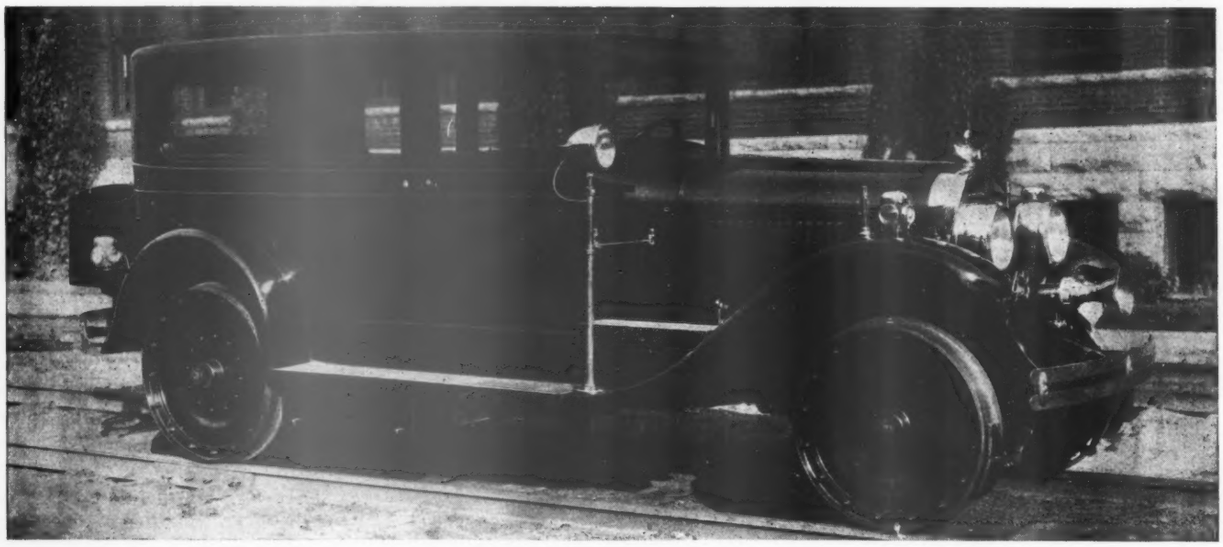
In this new arrangement, which was resorted to in order to minimize damage to the axles through the pounding of the wheels over rail joints and frogs and crossings, both the front and rear axles are carried in specially designed, spring-supporting journal boxes. The front axle journal boxes are equipped with ball bearings, and the rear axle boxes with self-alining, standard roller bearings. In conjunction with this change, the springs of the car were attached to the journal boxes and were strengthened by the addition



Turn-table jack for Cadillac rail inspection car

of two spring leaves. Additional stability, particularly, of the axles, has been secured by making the front of the car semi-underslung and by the provision of two heavy adjustable tie rods which tie each journal box to the frame of the car in such a manner as not to affect the action of the springs. The main function of these tie rods is to keep the axles and, therefore, the wheels in correct alinement.

which is mounted in an upside down position near the center of gravity of the car. This jack, which has a suitable turntable plate attached to the under side of the car frame and a broad head shoe for providing a stable support on a track tie, is raised and lowered through a hand-operated crank shaft which extends to one side of the car just below the running board. One of the illustrations shows the jack construction.



The Cadillac inspection car showing flanged wheels and auxiliary equipment

The wheels of the car are of special design, with cast-steel centers and steel tires which were turned down from small worn locomotive trailer tires. Between the center and the tire of each wheel is a filler of brake lining, which was provided to lessen the noise of the car and to deaden the shocks received at rail joints and when passing through special track work. The rear wheels of the car are 33 in. in diameter over the threads while the front wheels are only 30 in. in diameter.

Three Sets of Brakes Are Provided

As conditions of braking are more severe on the track than on the ordinary highway, three systems of brakes have been provided on the car. The ordinary foot brake operating on brake drums on the rear axle, the usual type of hand-operated emergency brake and a special supplementary brake which is applied by turning the steering wheel. This latter brake functions through brake shoes which act on the front wheels.

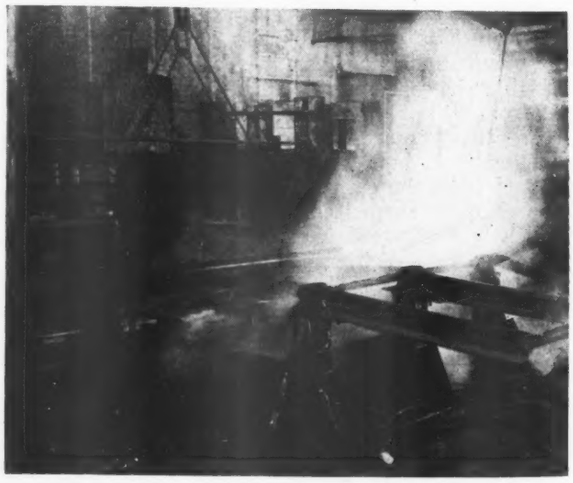
Other special auxiliary features of equipment on the car include an electric siren, an exhaust-operated horn, a hot-air heating system in which fresh air from the radiator fan is forced through a chamber around the exhaust pipe and then into the car, miniature marker and classification lights for night running, a high-powered spot light mounted on a standard on the running board for tunnel inspection work, a large metal trunk attached to the rear of the car for carrying tools and small inspection equipment, and two small metal boxes, one on each side of the car under the running board, for carrying flags, fusees, torpedoes, waste, oil, etc.

A Special Turning Jack Is Provided

Another of the more important special features of the car is the means provided for raising and turning it at any point on the track This consists essentially of a specially designed screw jack of five tons capacity,

In turning the car, the jack is centered over a tie and the shoe is lowered only sufficiently to make the wheel flanges clear the rails. In doing this, the entire weight of the car is supported directly through the car frame, including the weight of the wheels and axles which is transmitted directly to the frame by a heavy chain between the frame and each journal box. When the car has been raised free of the rails, it can easily be steadied and turned about by two men. The actual time required to make a complete turn of the car is about four minutes.

* * *



Heat treating mine car axles (Bloomsburg, Pa., plant)—One of a number of pictures shown at the American Car & Foundry meeting, of the New York Railroad Club, March 16, 1928

Balancing and Dynamic Loading of Locomotives

A theoretical discussion of the cross-balancing of main drivers and allowable axle loadings

By Dr. R. Eksergian
Engineering Department, Baldwin Locomotive Works, Philadelphia, Pa.

Part I

AN extended discussion by a number of prominent mechanical engineers in the railroad and railway supply industries of the problems pertaining to the counterbalancing of locomotives occurred at one of the Railroad Division sessions, held during the annual meeting of the American Society of Mechanical Engineers, December 3 to 7, 1928. This discussion followed the presentation of a paper on the balancing and dynamic rail pressure of locomotives by Dr. R. Eksergian, engineering department, Baldwin Locomotive Works, Philadelphia, Pa.

The problem of counterbalancing for minimum dynamic loading and rail stress is a basic design limitation for modern locomotives with limited axle loads. Two methods of balance are ordinarily used: Static balancing, where the difference in planes of the revolving weights is not taken into consideration, and dynamic balancing, where the planes of action are considered as well. As the former method is extensively used, the estimation of maximum rail pressure with the heavy overhanging revolving weights, is of considerable importance. In Dr. Eksergian's paper an analysis was made resulting in formulas and general methods for the determination of the maximum rail pressure and the corresponding position of the crank for systems of revolving weights. He also included a complete outline of balancing methods.

The balancing of the reciprocating parts introduces unbalanced vertical components. Dr. Eksergian made a general study of the dynamic effect of the reciprocating parts and revolving parts on the locomotive itself, both for two- and three-cylinder locomotives, counterbalanced statically and dynamically. This was followed in his paper by comparative studies of the relative effects when statically and dynamically balanced for two-cylinder locomotives; that is, as to rail pressure and the vibration of the locomotive itself. He also made a similar comparison of the dynamic loadings for two- and three-cylinder locomotives.

Dr. Eksergian made a brief survey of the nature of rail stress and the effect of counterbalancing and wheel spacing in augmenting the bending moment in the rail. Calculations are included in his paper for the rail and track loading of a 4-8-2 type, an eight-coupled and a three-cylinder compound locomotive. The last part of his paper is devoted to a study of weight transfer under maximum traction, including calculations for it with a Santa Fe 2-10-2 type locomotive. The author included in his paper an appendix containing special problems, such as the general formula for the vertical thrust of the connecting rod on the main pin, and an estimation of revolving weight, with experimental methods of determining the constants of a rod. The general dynamic equation of a locomotive for the fore-and-aft and nosing oscillations were also included.

The conclusions arrived at by Dr. Eksergian in his paper are that the cross or dynamic balance of main drivers should be made with modern power, and the allowable axle loading should be based on the maximum rail and track loading at the average operating speeds.

The following abstract contains only the mathematical analysis made by the author of the balancing of reciprocating parts and the methods used for the determination of the maximum rail pressure and the corresponding position of the crank for systems of revolving weights. Lack of space necessitates the publication of only a brief portion of the paper. This report has been divided into two parts, of which this installment is part one. The second part of the report will appear in the May issue and will include the conclusions arrived at by Dr. Eksergian, together with the ensuing discussion of his paper.

The following is an abstract of Dr. Eksergian's paper:

Abstract of Dr. Eksergian's Paper

It is important to appreciate that, provided we have ample space limitation for counterbalance, a complete balance of the revolving parts is possible. A balance of the reciprocating parts requires an opposed reciprocating system, as reciprocating bob weights, or a given combination of reciprocating parts, which with a locomotive offers great mechanical difficulties. Since, however, a revolving weight may always be de-composed into two harmonic components at right angles to each other, we may by the use of a revolving counterbalance partially balance the reciprocating masses by the component in the plane of the reciprocating parts, but always at the expense of a corresponding unbalance in the plane at right angles to the plane of reciprocation. Thus the balancing of a locomotive by revolving counterweights is at best a compromise, unless we can introduce several cranks with proper phasing, so that we have a completely opposed reciprocating system.

In large locomotives a real difficulty is the available-space limitation for the counterbalance in wheel centers, so that for small drivers, as in freight locomotives, it is frequently impossible even to counterbalance dynamically the revolving parts alone, particularly for the main driver. Thus a centrifugal couple is introduced, due to the revolving parts, which in view of the large overhangs causes a large dynamic rail loading. This couple increases with the overhang—that is, with the cylinder cen-

ters—so that in addition to reducing the revolving weights to a minimum it is equally important to reduce the cylinder centers and the other lateral distances of the revolving weights.

Assuming a revolving-weight balance possible, the dynamic augment depends upon the percentage of the reciprocating weights used in the counterbalance. While a considerable difference of opinion exists as to the degree of balance required for the reciprocating parts, it is, however, possible to maintain a constant proportion for different types, depending upon the relative mass and polar moment of inertias of the locomotives.

The unbalanced reciprocating parts set up three primary vibrations, namely: a longitudinal oscillation; that is, a translation of the locomotive to and fro; a "nosing" or angular vibration about a vertical axis in the horizontal plane; and a "pitching" or angular oscillation about a horizontal axis in the vertical plane, due to the offset of the center of gravity of the spring-borne parts from the plane of reciprocation. In the three-cylinder locomotives with cranks phased at 120 deg. the primary longitudinal oscillation and pitching moment are inherently eliminated. The nosing moment, however, is not eliminated. The degree of reciprocating balancing would therefore in this case depend upon the relative importance of the nosing component.

Two methods of balancing are ordinarily used: static balancing and cross or dynamic balancing. In static balancing, the balance is placed in the wheel opposite the resultant of the centrifugal effect of the adjacent revolving weights, disregarding the different planes of action of the revolving weights. In a dynamic balance, however, not only is the centrifugal effect of the revolving weights balanced, but their planes of action are taken into consideration and their moments are also neutralized.

It is important to appreciate, however, that so far as the total vertical loading on the track or the total longitudinal loading in a horizontal plane on the locomotive itself is concerned it is entirely immaterial whether we cross or statically balance the revolving weights. On the other hand, a static balance of the revolving weights introduces an unbalanced varying moment, in the vertical plane as well as in the horizontal plane, thus setting up an unbalanced couple reacting on the rail and frame.

In the balance of the reciprocating parts there are likewise two methods of balance. In cross or dynamic balancing the balancing weights are arranged in the plane of both drivers, so that their resultant reduces to an equivalent weight in the plane of reciprocation and opposite in phase to the cranks. Since a reciprocating weight may be considered as a component of a revolving weight, this component may thus be balanced by the equivalent revolving weight in the plane of reciprocation, either completely or partially at the expense of an unbalanced vertical component. In a static balance the balance weight is placed in the plane of the driving wheel; that is, there is a single balancing weight in the plane of the adjacent driver. The static balance is equally effective as cross-balancing in reducing the longitudinal and pitching oscillations, but it is not as effective in compensating for the nosing moment. Moreover, it is important to note that the action of the revolving weights themselves when statically balanced tends to augment the swaying moment.

Actually the space limitation in a driving wheel often results in a deficiency in balance, so that in many cases little advantage is obtained by direct cross-balancing. In other cases the dynamic augment placed in the main driver for a static balance considerably aids in effecting actually a better dynamic balance of the revolving parts.

It is important to differentiate clearly between dynamic track loading and rail loading. The former is the gross dynamic loading per pair of rails and is not affected by the planes of the revolving weights. The rail or wheel loading depends upon the centrifugal components and their planes of action. The dynamic track loading may be nil, while the rail loadings may have high values. The track loading affects bridge loadings, while the rail pressure sets up stresses in the rail and local superstructure.

Dynamic Effect of the Reciprocating Parts and Revolving Parts on the Locomotive Itself

The disturbing inertia forces of the mechanism of a locomotive are due to the kinetic reactions of the reciprocating parts. Since the introduction of balancing components by the use of revolving balance introduces unbalanced components normal to the plane of reciprocation, the real problem of balancing is to effect the best compromise for the least dynamic loading at the rail consistent with the maximum allowable disturbing effect of the unbalanced reciprocating parts. Obviously this depends upon the proportion of the reciprocating masses to that of the total mass and polar moment of inertia of the locomotive and cylinder centers.

In a cross or dynamic balance of the revolving parts the action of the reciprocating parts may be considered separately, so far as the vibration of the locomotive itself is concerned. The dynamic augment is then the additional balance in the wheel required to partially balance the reciprocating parts and augments the required balance for the equilibrium of the revolving weights.

In a static balance, however, the total fore-and-aft effect of the revolving weights is nil, just as in the vertical loading the total track loading is unaffected by the difference in planes. In considering the nosing moment of a locomotive, however, it is important with a static balance to consider the additional nosing due to the out-of-plane action of the revolving weights. Thus with a static balance the reciprocating nosing moment is augmented by the action of the revolving parts.

Considering the right crank leading left and making angle Θ, Fig. 1, in a two-cylinder locomotive, if

w = angular velocity of the cranks
m_r = mass of reciprocating parts
m_1 = revolving weights at cylinder centers
m_1' = total revolving weights at side-rod centers
m_{er} = counterbalance component for revolving weights in plane of wheel
m_{es} = counterbalance component in plane of driver for reciprocating parts when statically balanced
m_{ed} = equivalent counterbalance component in plane of reciprocation required for reciprocating balance when cross-balanced
L = cylinder centers
L' = side-rod centers
G = lateral distance between plane of balance when statically balanced

Then the fore-and-aft shaking force is

$(m_r - m_{ed})w^2r\ (\cos\Theta + \sin\Theta)$ (cross-balanced)
$(m_r - m_{es})w^2r\ (\cos\Theta + \sin\Theta)$ (statically balanced)

since

$$m_{er} = m_1 + m_1'$$

and the tangential reaction at the base of the drivers is nil.

The nosing or swaying moment is

$$(m_r - m_{ed})\frac{L}{2}w^2r\ (\cos\Theta - \sin\Theta) \text{ cross-balanced}$$

$$\left(m\phi\frac{L\phi}{2} - m_e\frac{G}{2}\right)(\cos\Theta - \sin\Theta) \text{ statically balanced}$$

where

$$m\phi L\phi = (m_r + m_1)L + m_1'L'$$
$$m\phi = m_r + m_1 + m_1'$$
$$m_e = m_{er} + m_{es} \text{ and } m_{er} = m_1 + m_1'$$

It is frequently more convenient to separate the nosing moment due to the reciprocating parts and their corresponding balance from the additional nosing moment due to the revolving parts and their balance.

We then have for the nosing moment with a static balance

$$M_D = \left(\frac{m_rL - m_{es}G}{2}\right)(\cos\Theta - \sin\Theta) + \left(\frac{m_1(L-G) + m_1'(L'-G)}{2}\right) \times (\cos\Theta - \sin\Theta)$$

$$= \left[\left(m_r \frac{L}{2} - m_{es}\frac{G}{2}\right) + m_1\left(\frac{L-G}{2}\right) + m_1'\left(\frac{L'-G}{2}\right)\right] \times (\cos\theta - \sin\theta)$$

The maximum force occurs when $\sin\theta = \cos\theta$, or $\tan\theta = 1$; that is, at angle $\theta = 45°$.

The maximum nosing moment occurs when $-\sin\theta - \cos\theta = 0$, $\tan\theta = -1$; that is, at an angle $\theta = 135$ deg. That is, the condition for maximum fore-and-aft vibration is represented by the cranks as in Fig. 2 and the maximum nosing as in Fig. 3.

The maximum shaking force is therefore

$$\sqrt{2}(m_r - m_{ed})w^2r \text{ and } \sqrt{2}(m_r - m_{es})w^2r$$

and the maximum nosing moments are

$$(m_r - m_{ed})\frac{w^2Lr}{\sqrt{2}} \text{ and } (m\phi L\phi - m_eG)\frac{w^2r}{\sqrt{2}}$$

for a dynamic and static balance, respectively.

The importance of the vibration, however, also depends

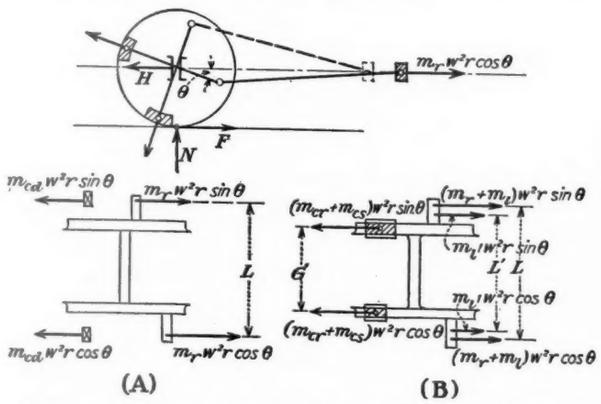


Fig. 1—A: Cross or dynamically balanced—B: Statically balanced

upon the relative mass and polar moment of inertia of the locomotive.

If M = the mass of the locomotive
I = the polar moment of inertia about a vertical axis through the center of gravity.

Assuming approximately a uniform distribution of weight with the locomotive as a rectangle of breadth b and length h, then

$$I = \frac{W}{12g}(b^2 + h^2) \text{ where } g = 32.2$$

The fore-and-aft vibration is given by

$$(m_r - m_{ed})w^2r\ (\cos\theta + \sin\theta) = M\frac{d^2x}{dt^2}$$

Integrating, we find, since

$$w = \frac{d\theta}{dt}$$

$$\frac{dx}{dt} = \frac{(m_r - m_e)wr}{M}(\sin\theta - \cos\theta) + \overline{V}$$

$$x = -\frac{(m_r - m_e)r}{M}(\cos\theta - \sin\theta) + \overline{Vt}$$

and therefore the maximum amplitude of the fore-and-aft vibration is (that is, when $\frac{dx}{dt} = O$)

$$x_{max} = \frac{m_r - m_{ed}}{M}\sqrt{2}\,r \text{ dynamically balanced}$$

$$x_{max} = \frac{m_r - m_{es}}{M}\sqrt{2}\,r \text{ statically balanced}$$

For the nosing oscillation, we have

$$\left(\frac{m_r - m_{ed}}{2}\right) Lw^2r\ (\cos\theta - \sin\theta) = I\frac{d^2\phi}{dt^2} \text{ cross-balanced}$$

$$\left(\frac{m\phi L\phi - m_eG}{2}\right) w^2r\ (\cos\theta - \sin\theta) = I\frac{d^2\phi}{dt^2} \text{ statically balanced}$$

Integrating, we have

$$\frac{d\phi}{dt} = \frac{(m_r - m_{ed})Lwr}{2I}(\cos\theta + \sin\theta) \text{ cross-balanced}$$

$$\frac{d\phi}{dt} = \frac{(m\phi L\phi - m_eG)}{2I} wr\ (\cos\theta + \sin\theta) \text{ statically balanced}$$

$$\text{and } \phi = \frac{(m_r - m_{ed})Lr}{2I}(\sin\theta - \cos\theta) \text{ cross-balanced}$$

$$\phi = \frac{m\phi L\phi - m_eG}{2I} r\ (\sin\theta - \cos\theta) \text{ statically balanced}$$

and the corresponding maximum amplitude occurs when

$$\frac{d\phi}{dt} = O,$$

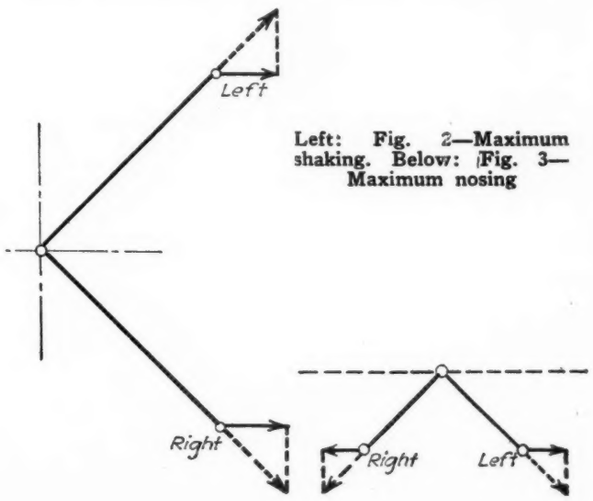
so that

$$\phi_{max} = \frac{(m_r - m_{ed})Lr}{\sqrt{2}I} \text{ cross-balanced}$$

$$\phi_{max} = \frac{(m\phi L\phi - m_eG)}{\sqrt{2}I} \text{ statically balanced}$$

Thus the fore-and-aft vibration depends only on the percentage of unbalanced reciprocating mass to the total mass of the locomotives, while on the other hand the swaying or nosing oscillation depends upon the ratio of the unbalanced moment of the reciprocating parts to the moment of inertia of the locomotive. The former component depends only on the masses, but the latter depends upon the configuration of the locomotive as well. Long wheelbase locomotives have their nosing considerably reduced over that of a short wheelbase type.

In an articulated construction, as in the Mallet or Garratt type of locomotive, the front unit is free from



Left: Fig. 2—Maximum shaking. Below: Fig. 3—Maximum nosing

the boiler. The nature of the nosing of the front unit is of interest. In a first approximation we will assume the nosing of the rear unit and boiler which is rigidly attached to it is of small order. (See Fig. 4.)

Let m_f = the mass of frame, etc., of front unit
I_f = polar moment of inertia of frame about its c. of g.
l = distance from boiler support to hinge joint
c = distance to center of gravity from hinge joint
F = friction force at front boiler support
R = lateral reaction at hinge induced by the nosing vibration

Then

$$(m_r - m_e)w^2r\frac{L}{2}(\cos\theta - \sin\theta) - F(l-c) - Rc = I_f\frac{d^2\phi}{dt^2}$$

$$R - F = M_{fc}\frac{d^2\phi}{dt^2}$$

so that

$$(m - m_c)w^2r\,\frac{L}{2}\,(\cos\theta - \sin\theta) - Fl = (m_fC^2 + I_f)\,\frac{d^2\phi}{dt^2}$$

Thus we see that the effective moment of inertia of the front unit is considerably increased by the lateral restraint of the hinge joint and that the unbalanced moment is decreased by the lateral friction moment of the front boiler support about the hinge. Therefore the nosing oscillations at the front unit are not so severe as one might at first suppose.

The Three-Cylinder Locomotive

With three-cylinder types we find two methods of crank phasing used, cranks at 120-deg. spacing and split-quadrant phasing. The latter offers advantages in an even exhaust for three-cylinder compounds and in a general reduction in side-rod loadings for either simple

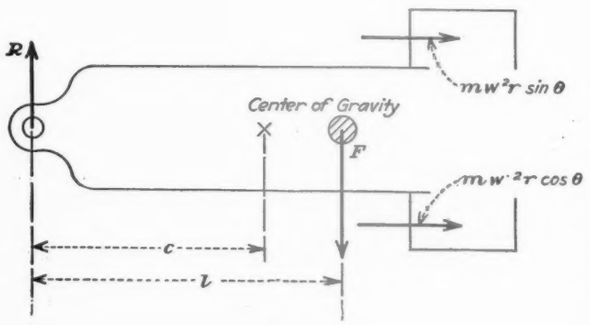


Fig. 4

or compound. The uniformity of torque, however, is not as satisfactory as with the three-cylinder at 120-deg. crank phasing.

With cranks at 120-deg. phasing the fore-and-aft force is nil, as can be shown from the expression

$$mw^2r\cos\theta + mw^2r\cos(\theta - 120) + mw^2r(\theta - 240) = 0$$

The nosing moment, with outside right leading outside left, is given by the expression

$$M_D = \frac{(m\phi L\phi - m_cG)}{2}\,w^2r\,(\cos\theta - \cos(\theta - 120))\ \text{static balanced}$$

and

$$M_D = \frac{(m_r - m_{cd})L}{2}\,w^2r\,(\cos\theta - \cos(\theta - 120))\ \text{cross-balanced}$$

where

$$m\phi L\phi = (m_r + m_1)L + m_1'L'$$
$$m\phi = m_r + m_1 + m_1' = m_{cs} + m_{cr}$$

Now

$$\cos\theta - \cos(\theta - 120) = 3/2\cos\theta - \frac{\sqrt{3}}{2}\sin\theta$$

so that the maximum nosing occurs when

$$\frac{dM_D}{d\theta} = -\frac{3}{2}\sin\theta - \frac{\sqrt{3}}{2}\cos\theta = 0,\ \tan\theta = -\frac{1}{\sqrt{3}}$$

or with right crank at 150 deg. from the forward dead point. Therefore the maximum nosing moment is

$$M_{Dmax} = \frac{\sqrt{3}}{2}\,(m\phi L\phi - m_cG)w^2r\ \text{static balanced}$$

$$M_{Dmax} = \frac{\sqrt{3}}{2}\,(m_r - m_{cd})w^2r\ \text{dynamic balanced}$$

These relations may readily be shown graphically. Thus we may always assume the effect of a reciprocating mass as equivalent to the component of a revolving weight projected in the plane of reciprocation. It is therefore evident that with cranks at 120-deg. phasing the projected components of revolving weights at these crank angles is nil. (See Fig. 5.) Thus,

$$mw^2r\,(\cos\theta + \cos(\theta - 120) + \cos(\theta + 120)) = 0$$

On the other hand, for the nosing moment (see Fig. 6) we have only to consider the moments of the outside cylinders, which are phased at 120 deg. apart.

The maximum nosing is obviously

$$mw^2r\cos 30\ \text{deg.} \times L = \frac{\sqrt{3}}{2}\,mw^2rL$$

With split-quadrant phasing of the cranks of a three-cylinder locomotive, the outside cranks are arranged at quadrature and the inside crank is placed opposite to the bisector of the quadrant of the outside cranks. It is easy to see that there is now introduced a small unbalanced shaking force, since

$$mw^2r(\cos\theta + \cos(\theta - 90) + \cos(\theta - 225))$$
$$= \frac{0.41}{\sqrt{2}}\,mw^2r(\cos\theta + \sin\theta)$$

This reaches a maximum when $\tan\theta = 1$, or $\theta = 45$ deg., or 225 deg., so that the maximum shaking force is

$$0.41\ mw^2r$$

On the other hand, the nosing moment is reduced over that in 120-deg. crank phasing, since

$$M_D = mw^2r\,\frac{L}{2}\,(\cos\theta - \sin\theta)$$

with a maximum value the same as with any two-cylinder locomotive of the same reciprocating weight.

Thus we find the total unbalance of three-cylinder locomotives whether split-quadrant or 120-deg. phasing practically the same. It is further important to note that in locomotives with long wheelbase and corresponding large polar moments of inertia there result small angular oscillations. Since the fore-and-aft vibration is practically nil and the nosing oscillations small, the resultant vibration due to unbalanced reciprocating masses is considerably reduced over two-cylinder types. For this reason a much smaller percentage of reciprocating balance can be used for three-cylinder types. In fact, with sufficient size wheel centers for effective cross-balance

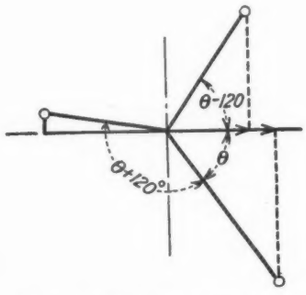


Fig. 5—Shaking force nil

of the revolving weights, the three-cylinder type offers a very complete balancing and thus permits a considerable increase in static rail load over the two-cylinder type.

We will now consider the general relations for the actions of the reciprocating parts for any number of cranks and with the planes of reciprocation for some of the cranks inclined to the horizontal. In the locomotive problem we will consider only the primary harmonics, which is equivalent to neglecting the obliquity of the connecting rod.

We can readily visualize the resolutions by considering the reciprocating forces as projections of revolving weights in the plane of reciprocation. When the reciprocating masses reciprocate in the same plane, then if α_1, α_2, etc., are the lags of the several cranks from the leading crank making an angle Θ from the dead-center position, then the unbalanced resultant has a magnitude

$$F = m_1w^2r_1 \cos\theta + m_2w^2r_2 \cos(\theta - a_2) \ldots m_nw^2r_n \cos(\theta - a_n)$$

and the unbalanced moment with respect to any transverse reference plane is

$$M_d = m_1w^2r_1l_1 \cos\theta + m_2w^2r_2l_2 \cos(\theta - a_1) \ldots m_nw^2r_nl_n \cos(\theta - a_n)$$

so that the position of the resultant disturbing force from the reference plane is at a distance $l = \frac{M_d}{F}$. Or we may consider an unbalanced force F in the plane of reference and reciprocation, together with a couple $F \cdot l = M_d$ in the plane of reciprocation.

When the planes of reciprocation, however, (see Fig. 7) make angles β_1, β_2, etc., with respect to the plane of reciprocation of the initial crank with cranks phased by

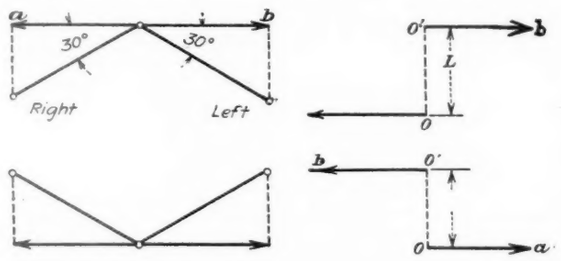


Fig. 6

crank angles a_1, a_2, ... a_n with respect to the initial crank, then, if we consider axis along and normal to the initial reciprocating plane, we have

$$\Sigma X = m_1w^2r_1 \cos\theta + m_2w^2r_2 \cos(\theta - a_1 + \beta_1) \cos\beta_1, \text{ etc.}$$

$$\Sigma Y = m_2w^2r_2 \cos(\theta - a_1 + \beta_1) \sin\beta_1 + m_3w^2r_3 \cos(\theta - a_2 + \beta_2) \times \sin\beta_2, \text{ etc.,}$$

so that the resultant unbalanced force is

$$R = \left(\sqrt{\Sigma X^2 + \Sigma Y^2}\right) \text{ with an angle } \phi = \tan^{-1}\frac{\Sigma Y}{\Sigma X}$$

with respect to the initial plane of reciprocation.

For the moments we consider these resolved into planes OXZ and OYZ with respect to any transverse reference plane perpendicular to the OZ axis. If the reciprocating forces lie at distances l_1, l_2, etc., from the reference plane along the OZ axis, then

$$\Sigma M_x = m_1w^2r_1l_1 \cos\theta + m_2w^2r_2l_2 \cos(\theta - a_1 + \beta_1) \cos\beta_1, \text{ etc.}$$

$$\Sigma M_y = m_2w^2r_2l_2 \cos(\theta - a_1 + \beta_1) \sin\beta + m_3w^2r_3l_3 \cos(\theta - a_2 + \beta_2) \times \sin\beta_2$$

so that the resultant moment is

$$M = \sqrt{(\Sigma M_x^2 + \Sigma M_y^2)}$$

with its plane of action making an angle

$$\phi' = \tan^{-1}\frac{\Sigma M_y}{\Sigma M_x}$$

We may consider this resolution as an unbalanced force R making an angle $\Theta = tan^{-1}\frac{Y}{X}$ in the plane of reference together with a couple M making an angle $\Phi' = tan^{-1}\frac{M_y}{M_x}$.

This theory, however, is not entirely applicable to the inclined-cylinder locomotive because of the fact that a great part of the locomotive is spring-suspended, so that the vertical component affects locally the particular driving axle which is connected to the reciprocating parts of the inclined cylinders.

The horizontal component, however, has its full effect on the locomotive, and the equations for ΣX and ΣM_x may be applied directly for the fore-and-aft and swaying moments, respectively. We note l_1, l_2, etc., are the lateral spacings of the cylinders.

On the other hand, the vertical components ΣY and ΣM_y affect locally the particular driving axle, which are coupled with the reciprocating parts under consideration. ΣY augments the total track loading of the individual driver and ΣM_y augments the lateral moment owing to the difference in planes of the revolving parts of the particular axle.

In the three-cylinder locomotives we find the middle cylinder inclined, while the outside cylinders are horizontal. Then

$$\Sigma X = m_1w^2r \cos\theta + m_2w^2r \cos(\theta - 120) + m_3w^2r \cos(\theta - (240 + \delta) + \beta_1) \cos\beta$$

$$\Sigma M_x = m_1w^2r \frac{L}{2} \cos\theta - mw^2r \frac{L}{2} \cos(\theta - 120)$$

since moments are taken about the middle cylinder, which has no effect on the swaying of the locomotive.

Since β is small, $cos\ \beta = 1$ approx., and if the crank is displaced backward $\delta = \beta$, the horizontal reaction ΣX on the fore-and-aft vibration is nil. Thus by setting the crank back equal to the inclination of the cylinders, we can treat the central cylinder in a horizontal plane.

Combined Effect of Revolving Weights With Reciprocating Parts

The fore-and-aft vibration of the locomotive is unaffected by the revolving parts alone when balanced either statically or dynamically. That is, so far as the fore-and-aft vibration is concerned, it is entirely immaterial whether we cross-balance or statically balance.

The nosing moment is also unaffected for a cross-balance of the revolving parts. On the other hand, a static balance materially increases the nosing moment.

We have seen that whether we statically balance or cross-balance the reciprocating parts alone, it is fairly immaterial so far as the resultant vibration of the locomotive is concerned.

The reduction in nosing moment by cross-balance permits a lower percentage of reciprocating balance. But it

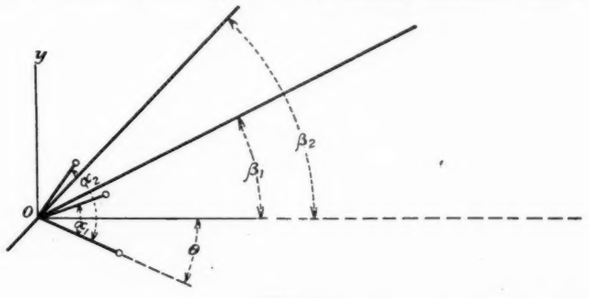


Fig. 7

is always important to observe that this reduction increases the out-of-balance condition for the fore-and-aft vibration. We may compromise by equating the reduction in nosing to the increase in fore-and-aft vibration.

Let k_s = percentage of reciprocating balance when balanced statically
k_d = percentage of reciprocating balance when balanced dynamically

for the equivalent revolving weight in the plane of the cylinders.

Then in a static balance the fore-and-aft vibration is proportional to

$$(\sqrt{2} - 2k_s \cos 45 \text{ deg.})w_r = (1 - k_s)\sqrt{2}w_r$$

while the nosing moment is proportional to

$$0.707(L - k_sG)w_r + 0.707(w_1(L - G) + w_1'(L' - G))$$

For a dynamic balance we have

$(1 - k_d)\sqrt{2}w_r$ for the fore-and-aft vibration
$0.707(1 - k_d)Lw_r$ for the nosing moment.

Then, equating the percentage increase of fore-and-

aft to the percentage decrease of nosing when balanced dynamically over that balanced statically, we have

$$\frac{1-k_d}{1-k_s} - 1 = 1 - \frac{(1-k_d)Lw_r}{w_r(L-k_sG) + w_1(L-G) + w_1'(L'-G)}$$

If we let the expression

$$w_r(L-k_sG) + w_1(L-G)w_1' + w_1'(L'-G) = M$$

Then

$$\frac{k_s-k_d}{1-k_s} = 1 - \frac{(1-k_d)Lw_r}{M}$$

so that

$$k_d = \frac{\frac{Lw_r}{M} + \frac{k_s}{1-k_s} - 1}{\frac{Lw_r}{M} + \frac{1}{1-k_s}}$$

Consider data from a Mountain type locomotive

$L = 93''$, $L' = 77''$, $G = 60''$
2551 = weight of reciprocating parts
$w_r = 319$ = weight per wheel reciprocating balance (50 per cent balance)

Reciprocating and Revolving Weights

	No. 1	No. 2, main	No. 3	No. 4	
Reciprocating weight.....	319	319	319	319	Cylinder centers
Revolving weight.....	...	1040	...	...	Cylinder centers
Revolving weight.....	260	958	660	260	Side-rod centers
Hub weight and pin.....	187	466	187	187	

Then

$$w_r = 2551,\ w_1 = 1040$$
$$w_1' = 260 + 958 + 660 + 260 = 2138,$$

if the comparison is on the cross-balance, or 958 if the cross-balance is only for main drivers. Thus for a total cross-balance $k_d = 0.345$ if $k_s = 0.5$ and for a main driver cross-balance $k_d = 0.363$ if $k_s = 0.55$

The dynamic augment in the plane of the wheels for an equivalent revolving weight $0.345\ w_r$ or $0.363\ w_r$ is

$$1.305 \times 0.345 = 0.45w_r \text{ for complete cross-balance}$$
$$1.305 \times 0.363 = 0.47w_r \text{ for partial cross-balance}$$

The reduction in wheel balance for the reciprocating parts by cross-balancing, particularly the main driver, amounts to from 6 to 10 per cent. As will be noted from the analysis, this feature is mainly due to the cross-balancing of the revolving parts of the main driver.

Thus we note that cross-balancing amounts to a substantial saving in the required balance weight in the wheel for the reciprocating parts. In other words, the true dynamic augment (for the reciprocating parts) is reduced by cross-balance. It is to be noted that this gain is mostly due to the main wheel.

It must be appreciated that the preceding analysis is but a crude approximation for arriving at some idea as to what percentage of the reciprocating parts should be used for the equivalent revolving weight at cylinder centers for the reciprocating parts.

There are many factors that may legitimately modify our conclusions. In the first place, in the analysis no consideration is given to the polar moment of inertia, or the mass of the locomotive. With a long wheelbase engine the fore-and-aft force is of more importance than the nosing moment, so that in comparing a cross-balance percentage with a static balance we should keep the fore-and-aft vibration nearly the same. On the other hand, with a small polar moment of inertia the nosing vibration may be the most important, so that the advantage of cross-balancing, so far as the angular vibration of the locomotive itself, will permit a lower percentage of reciprocating balance to be used.

(To be concluded in the May issue)

THE UNION PACIFIC, on February 23, following a week's conference with representatives of the Shop Employees' Association, effected an agreement which provides for wage increases ranging from 2 cents to 5 cents an hour for 10,787 mechanical department employees on that railroad, the Los Angeles & Salt Lake, the Oregon-Washington Railroad & Navigation Company, and the Oregon Short Line.

Shop employees on the Chicago, Rock Island & Pacific and the Chicago, Rock Island & Gulf have been granted an increase in wages ranging from 2 cents to 5 cents an hour through the signing of an agreement between representatives of those railroads and the Association of Rock Island Mechanical and Power Plant Employees at Chicago. The agreement affects about 7,020 shop and power plant employees and 270 coach cleaners. The maximum wages to be paid under the new schedule will be 81 cents an hour.

Machinists, boiler makers, blacksmiths, sheet metal workers, electrical workers, car men, engine inspectors, operators of bolt machines, bulldozers, pneumatic hammers and annealing furnaces, babbittmen, laggers and clampmen, and cranemen and crane directors now receiving 59 cents or more per hour have been given an increase of 5 cents an hour. Helpers, regular and helper apprentices and helpers on babbitt fires and cranemen and crane directors now receiving less than 59 cents an hour and power plant engineers were given an increase of 3 cents an hour. The wages of junior helpers, coach cleaners, power plant firemen and other power plant employees were advanced 2 cents an hour. Piece work checkers' wages were advanced $10 a month while the earnings of piece workers were increased 5 per cent.

The wages of 2,030 mechanics, helpers and apprentices in the locomotive and car departments of the Texas & Pacific have been increased by an amount which will add $206,500 to the railroad's annual payroll expenditure. The increase affects 900 mechanics, who will receive an addition of five cents an hour; 145 semi-skilled mechanics, four cents an hour; 815 helpers, three cents an hour, and 170 apprentices, from one to three cents an hour. The advances are made under an agreement which will remain in effect for one year.

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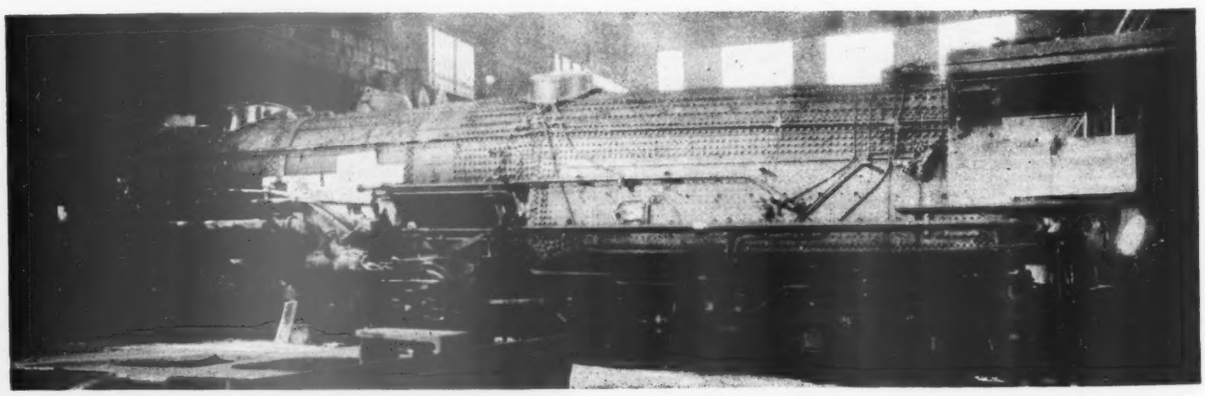


The Northern Pacific single-expansion articulated 2-8-8-4 type locomotive, No. 5000, in the erecting shop of the American Locomotive Company, Schenectady, N. Y.

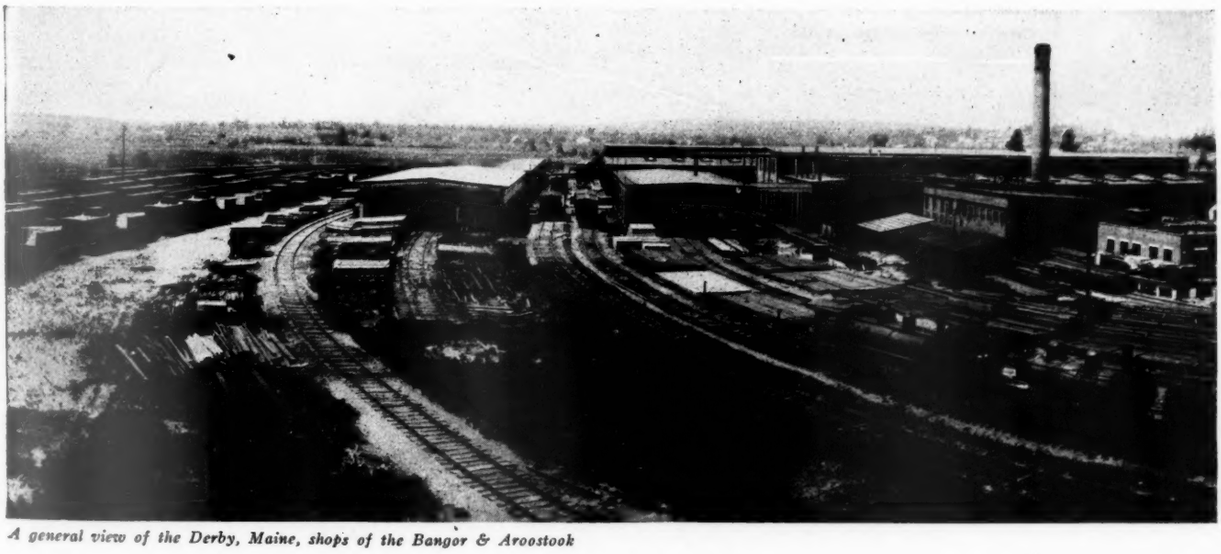
Keeping Records of Car Repair Costs

The Bangor & Aroostook has set up an effective but inexpensive system

IN many instances an elaborate cost-accounting system is not much more effective than some simple, direct system that is available to smaller railroads; the overhead expense is comparatively small but the results obtained are satisfactory and provide an accurate means of obtaining valuable information and certain basic data on repair costs that enables the management to know what it does actually cost to maintain its freight cars as far as general or any shop repair work is concerned. In addition to knowing the total cost per unit for repairs, it is possible to segregate the operations so that the costs of truck, underframe and superstructure repairs may be had for comparative purposes. Such data is especially valuable in keeping a proper record of roof renewals.

The Bangor & Aroostock makes all heavy freight car repairs at its Derby, Me., shops, the schedule of which calls for 100 heavy repairs each month. This schedule is based on the number of freight cars owned (4,322), and provides for class repairs of every car as least once in four years, if necessary.

A large amount of the traffic on this road is roll paper. The manufacturers of this commodity ask for a strictly "Class A" car, not only from a mechanical standpoint, but the interior must also be watertight with no protruding nails or bolt heads. The floor must also be properly maintained. In northern Maine where the winters are rigorous, the freight equipment that has its home point within those borders must often operate in adverse weather. Besides paper, the shipments of potatoes during the fall and early winter are handled in box cars, later supplemented by the use of refrigerator



A general view of the Derby, Maine, shops of the Bangor & Aroostook

cars. Potato shipments require an unusually good car, as many are shipped in bulk and unless the cars are provided with good interiors, clean floors, etc., claims are liable to result. The job of maintaining such equipment necessarily is expensive and for that reason it was felt advisable to operate some simple system that would truly indicate repair costs.

In May, 1925, such a system was installed at the Derby shops, utilizing the part-time services of one clerk with the title of shop accountant. The two principal sources of information for use in this record are (1) the shop material orders and (2) shop time cards. Instructions were issued to the track foremen to apply car numbers to material orders and to the time cards. As most of the freight car repair work is done on a piece-work basis and as each car is handled individually, the piece-work inspector's reports are also used for compiling cost data. From these piece-work sheets and daily work slips, it is possible to obtain not only the labor costs, but man-hours as well, the latter being the accepted basis for determining the class of repairs. These two sets of records are handled by the shop accountant, who draws off the detail for each car. Material slips are priced by the general storekeeper and returned to the shop accountant and afterwards go back to the general storekeeper, who uses them for making up his monthly report of material charges to operating expense accounts for the major statement of costs that is used by the general auditor in his reports to the Interstate Commerce Commission. By using the same basic record, the material costs, as shown on the shop record, are in accord with those reported to the auditor. This prevents any great variation in the summary. With the labor and material charges available, together with the car number, by the assessment of the allowed on each overhead, the total cost of each particular repair job is easily computed. The separation of labor and material charges against any particular portion of the car simply requires but a further analysis of the data already at hand. For the purpose of having a definite set-up for comparative purposes, the cars going through the shops are classified as to man-hours applied as follows:

Class	Number of man hours
1	Over 150
2	80 to 150
3	40 to 80
4	20 to 40
5	1 to 20

With this information available over a period of a year, a record of great value is set up.

Monthly reports of the operations are made to the interested officers. The data on these reports are transferred according to car numbers to permanent card records so that each card shows the cost of repairs to that particular unit since the installation of the cost repair system. This record is carried further, to the extent that the various classes of equipment are combined so that any class of car owned can be readily studied to determine its serviceability.

The only expense connected with the maintenance of this record is the part-time assignment of a clerk's rate and the small amount of special stationery needed.

For a small railroad with not more than four or five thousand cars, which has centralized repair points, this system offers a solution to a difficult problem.

Generally speaking, the cost of locomotive repairs is well kept, but on account of the seemingly large mass of details connected with a record of freight car repair costs, that portion of the work has been neglected in many instances. It is not only possible to maintain a good record, as herein described, but it is being done and with a high degree of satisfaction. This system may be and has been extended to cover passenger and work equipment repairs with no noticeable added expense. The first few months of accommodating this plan to the existing shop system are the hardest and experience shows that it is wise to make the system fit the shop plan rather than to try to rearrange the plan to accommodate the system.

Safety Guard for Emery Wheels

WITH the installation of a new combination car-journal turning and grinding lathe at the Boston & Albany car shops, at West Springfield, Mass., a new type of a wheel guard was applied, designed for quick and easy removal and replacement. The guard support is made from a piece of 3-in. by 1⅛-in. by 7⅜-in. steel, one end of which is machined out to fit over

An emery wheel guard which can be quickly removed and replaced

the grinding-wheel spindle cover. The support is drawn tight by a ½-in. bolt and nut that passes through the lower ends of the split portion of the support. A ⅝-in. hole is drilled in the top end of the guard support. A bar, which can be adjusted to any height, fits into the ⅝-in. hold. It is held in position by a ⅜-in. set screw. A ⅜-in. diameter hole is drilled through the upper end of the vertically adjustable bar in which fits another adjustable bar, on the end of which is welded the wheel guard. Thus, the guard is adjustable vertically and horizontally and can be quickly removed and replaced by loosening only one set screw. This design eliminates the removal of bolts and clamps before the guard can be removed. The wheel guard is made from thin sheet metal, welded together.

C. & N. W. Freight-Car Repair Facilities at Proviso

Entire layout developed to minimize material handling—Effective organization and schedule employed

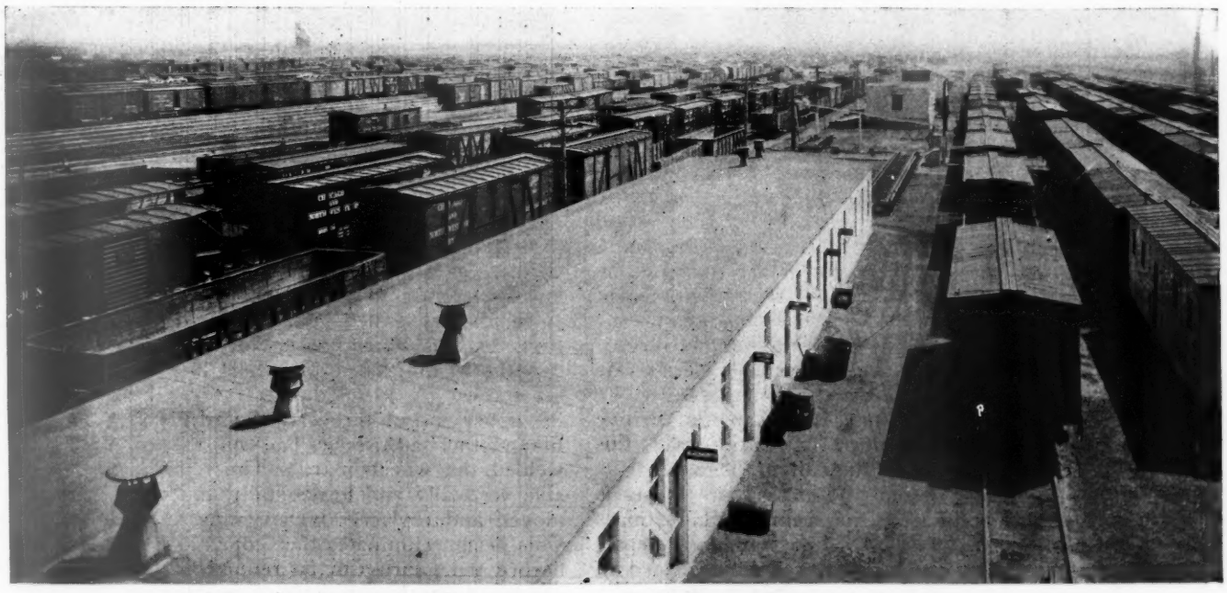
THE Chicago & North Western operates the largest freight terminal, transfer house and classification yards in the world at Proviso, Ill., 13 miles west of Chicago, the track layout affording a total capacity of 26,000 cars and provision being made for handling 15,000 cars a day. In order to repair freight equipment becoming bad order in the Proviso terminal, as well as cars received through interchange and from the line, car repair tracks and shop buildings have been located at a strategic point in the terminal near Wolf Road, South Proviso, as shown in the drawing. This repair station is at the present time worked to only about 50 per cent capacity, the output, with a total mechanical force of 185 men and 10 supervisors, being about two rebuilds and 80 medium and light repairs a day. Box-car equipment is handled for the most part, heavy and medium repairs predominating. Modern facilities for repairing freight equipment in the most economical manner have been provided, particular attention being paid to minimizing material handling. An effective supervisory organization and a schedule showing actual time worked, against conservative time allowances for detail car-repair operations, contribute greatly to the efficiency.

Referring to the drawing, it will be noted that the 15 repair tracks, accommodating a total of 512 cars, extend east and west, being separated practically in the middle by the car repair buildings. This permits material to be moved from the main source of supply with equal readiness to the tracks north or south of the buildings, and greatly reduces the total distance necessary to transport the material. The advantages of this method will be particularly apparent in the future when repair operations are carried on more extensively on the tracks south of the building, now largely used for storage purposes.

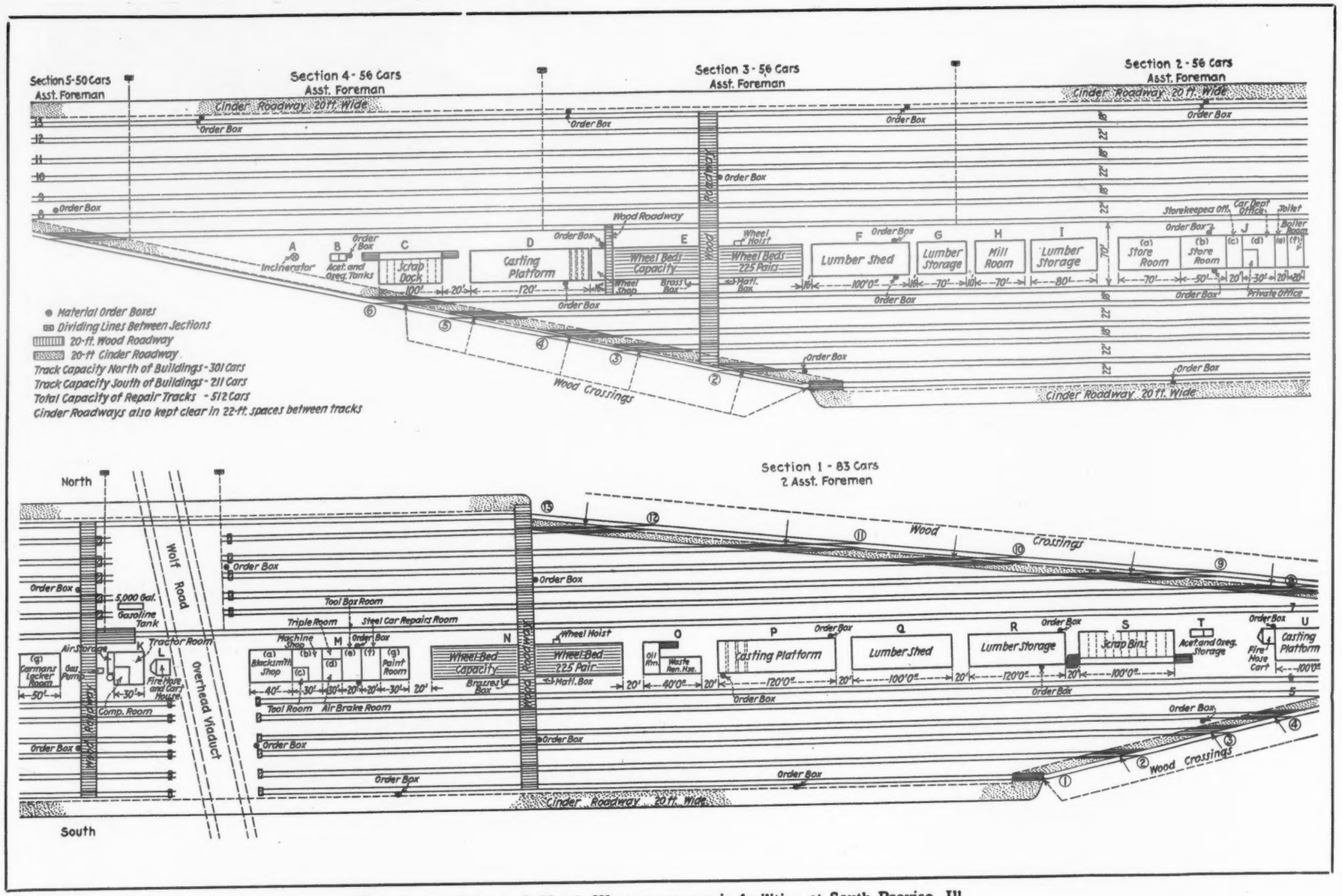
The repair tracks have a total length of about 3,200 ft., and, with the same objective of reducing trucking distances, it will be noted that two units of some of the more important repair facilities have been provided. For example, wheels can be quickly trucked to any point in the repair tracks from one or the other of the two wheel beds, whichever is nearer. Similarly, duplicate lumber sheds, casting platforms, scrap docks, gas-storage houses and incinerators are provided, this double-unit arrangement effectively reducing the distance that a great majority of the material must be moved. The mill room, storeroom, offices and shop building are, of course, located approximately in the center of the lay-out.

Cinder Roadway Around the Repair Tracks

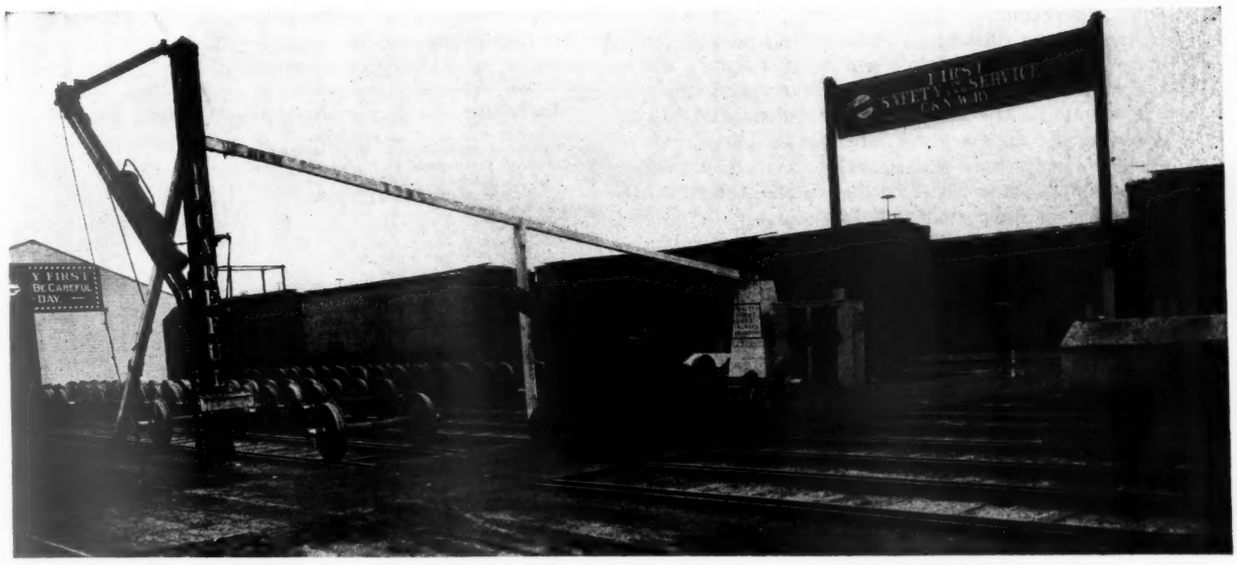
For the movement of car repair material, gasoline tractors, numerous trailers and trucks are used on the 20-ft. cinder roadway, which completely surrounds the repair tracks. Ample provision for north and south



General view of Proviso repair tracks and transportation yard



Plan of new Chicago & North Western car-repair facilities at South Proviso, Ill.



Wheel bed and hoist for handling wheels—Crane equipped tractor in the foreground

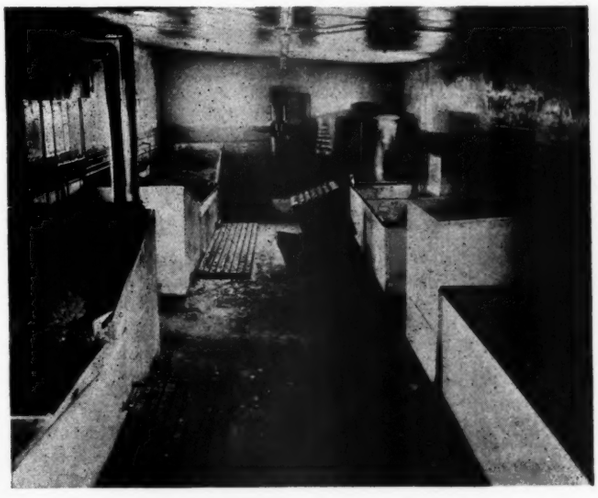
cross movement is made by means of three wood roadways which give ready access to cinder roadways in the 22-ft. spaces between alternate track centers. These latter roadways are kept clear and unobstructed, thus permitting prompt movement of tractors from the supply point to any car on any track.

Three gasoline tractors, equipped with crane attachments for handling wheels, truck sides, heavy castings, etc., are used in addition for hauling all kinds of standard and special-purpose trailers, a trailer loaded with lumber being shown in one of the illustrations and a special trailer for car wheels in another. Two Ford trucks form a rapid and extremely convenient method of supplying light-repair material to any point in the repair tracks.

Material is supplied to the cars in advance of the assignment of car repairers, and, in working this plan to a

Locker room building and Ford truck used for distribution of light material

satisfactory conclusion, cards indicating material requirements are deposited in order boxes located at suitable points throughout the repair tracks. These order cards, containing a notation of the time each order is placed, material required, car number, initials, track number, foreman's name and date, are later picked up by the light delivery trucks, which return promptly with the material, if not too heavy. Orders for bulky or heavy material also are promptly filled by the material supply gang with the proper truck equipment. By this system, necessary repair material is secured at any point



Interior of the oil and packing reclamation house

on the repair tracks without the necessity of individual car repair men or helpers leaving their work to get it.

Another feature of considerable importance is the provision of six special supply boxes on wheels, with compartments, as shown in one of the illustrations, for carrying a full supply of standard light material, such as bolts, nuts, cotters, washers and miscellaneous small castings. These supply-box trailers, maintained by the stores department, are returned periodically as necessary to the storeroom for checking and refilling. There is one supply trailer for each of five gangs, one extra trailer always being available to replace the others as they are sent one by one to the storeroom for refilling. Two supply trailers with double compartments for han-

dling old and reclaimed journal packing are provided.

Referring to the drawing and table, the purpose and size of each building or facility will be apparent. Next to the incinerator *A* is the acetylene and oxygen storage house *B*, divided into two parts by a substantial brick wall to reduce the fire hazard. The elevated scrap dock *C*, with truck inclines at either end, is divided into sections of adequate capacity for the various classes of scrap, which can be sorted and subsequently handled into scrap cars with minimum effort. The casting platform *D*, made of heavy timber, provides for the storage of heavy materials and is equipped with the necessary covered storage racks for smaller castings. The wheel bed *E* is equipped with double rails for compact wheel storage and has a total capacity of 225 pairs of wheels. It is served by a pneumatic hoist for double decking wheels in loading and has a large "Safety First" sign over the wood roadway. The illustration clearly shows one of the crane-equipped gasoline tractors and the type of two-wheel trailer used for handling car wheels. Racks for new brasses are shown at the left of the "Safety First" sign and a large scrap brass box on the ground at the right. Just west of this wheel bed is a 16-ft. building in which cut journals are reconditioned with a Pearce portable journal-turning machine. This machine is sometimes taken directly to the car.

The 100-ft. lumber shed *F* is designed to give ample protection to finished lumber and, at the same time, permits getting at it readily for loading on trailers. The lumber shed illustrated also carries a large "Safety First" sign. A tractor and loaded trailer are shown. The outside lumber storage space is shown at *G* and the mill room at *H*. The latter is equipped with the latest machinery needed for a repair point of this size, consisting of a Greenlee combination boring and mortising machine, a heavy-duty rip saw and a cut-off saw. Another lumber storage space is provided at *I* and the main supply building, offices, boiler room and locker room at *J*. The location and size of each subdivision of building *J* are shown in the table.

Individual Car-Repair Buildings at South Proviso

A—Incinerator	.....
B—Acetylene and oxygen storage house	.....
C—Elevated scrap dock	100 ft. by 32 ft.
D—Casting platform	120 ft. by 32 ft.
E—Wheel bed (capacity 225 pairs)	172 ft. by 32 ft.
F—Lumber shed	100 ft. by 32 ft.
G—Lumber storage	70 ft. by 32 ft.
H—Mill room	70 ft. by 32 ft.
I—Lumber storage	80 ft. by 32 ft.
J—Storeroom, offices, etc.	260 ft. by 32 ft.
a—Storeroom for rough material	70 ft. by 32 ft.
b—Storeroom for finished material	50 ft. by 32 ft.
c—Storekeeper's office	20 ft. by 32 ft.
d—Car department offices	30 ft. by 32 ft.
e—Toilet	20 ft. by 32 ft.
f—Boiler room	20 ft. by 32 ft.
g—Carmen's locker room	50 ft. by 32 ft.
K—Air compressor and tractor building	30 ft. by 32 ft.
L—Fire hose house	.....
M—Main shop building	170 ft. by 32 ft.
a—Blacksmith shop	40 ft. by 32 ft.
b—Machine shop	30 ft. by 32 ft.
c—Tool room	.....
d—Air brake room	30 ft. by 32 ft.
e—Toolbox room	20 ft. by 32 ft.
f—Steel car repairers' room	20 ft. by 32 ft.
g—Paint room	30 ft. by 32 ft.
N—Wheel bed (capacity 225 pairs)	172 ft. by 32 ft.
O—Waste reclamation house and oil room	40 ft. by 32 ft.
P—Casting platform	120 ft. by 32 ft.
Q—Lumber shed	100 ft. by 32 ft.
R—Lumber storage	120 ft. by 32 ft.
S—Elevated scrap dock	100 ft. by 32 ft.
T—Acetylene and oxygen storage	.....
U—Casting platform	100 ft. by 32 ft.
V—Incinerator (not shown)	.....

The main store building is divided into two sections,

West end lumber shed, showing the tractor and trailers used for distribution of lumber

one for housing finished material and the other for storing rough material. The finished material is handed out by an employee in charge, car repairers or helpers being prohibited from entering this section. It is found that this practice has the result of speeding up the operation and keeping the building in an orderly condition at all times. The men's quarters in building *J* are ample in capacity for the force employed and provide sanitary toilet facilities and metal lockers for personal effects.

dirt and short strands to drop out. The packing is then placed in one of the renovating tanks, shown at the left in the illustration, where it is heated, soaked in filtered oil and placed on the drain boards to drain off surplus oil. It is transferred to the outgoing tank from which it is passed through the chute to the packing-supply trailer as needed. This method eliminates the necessity of truckers, repairmen or any outside employees entering the oil house. Oil tanks are buried and oil drawn from them by modern pumps. The press shown in one

Interior of the wood working mill, which is equipped with modern machinery

Building *K* houses the air compressor and serves as a garage for the tractors. In the compressor room is an electrically-driven air compressor, providing sufficient capacity for charging the air line, the joints of which are welded throughout.

The shop building *M* is divided into seven sections as shown in the table to provide for the blacksmith shop, machine shop, tool room, air-brake room, storage room for employees' tools, steel-car repairers' room and paint shop.

A duplicate wheel bed, lumber shed, scrap dock, casting platform, etc., are provided near the east end of the repair tracks. An interior view of the oil storage and packing renovating plant is given in one of the illustrations. The plant has complete facilities for renovating packing, filtering oil, etc. Packing taken from the journal boxes is delivered by the special supply trailers mentioned to the outside of the building, passing through a chute in the east end of the building into a receiving tank, from which it goes into the picker. Revolution of the picker at about 18 r.p.m. permits the of the illustrations is for reclaiming the oil from waste as it leaves the picker. The capacity of this packing-reclamation plant is about 2,000 lb. daily.

Supervision and Schedule

At present the supervision includes a general foreman, assistant general foreman and eight assistant foremen. It will be observed from the drawing that the repair tracks are divided into five sections, supervised by a total of six assistant foremen. In addition, there are two assistant foremen, whose duties are general throughout the entire repair track, supervising miscellaneous labor, including air-brake men, supply men, laborers, etc. Section 1, with a track capacity of about 83 cars, is supervised by two assistant foremen, one of whom has recently been assigned to devote his entire time, together with that of his men, to a series of rebuilds in this section. Sections 2, 3 and 4, with a track capacity of 56 cars each, and Section 5, with a capacity of 50 cars, are each supervised by an assistant foreman.

The way in which repairs to freight equipment re-

ceived at Proviso repair tracks are scheduled is somewhat as follows: Bad order cars are set in during the night on tracks 7 and 8. The assistant foremen inspect the cars in their respective territories the first thing in the morning, checking with the bad-order cards, deciding what work is to be done and marking the "Original Record of Repairs" cards, which are then tacked to the car sides, or underneath in stormy weather. The assistant foremen fill out the material-order cards which are placed in the nearest order box and handled subsequently as described. In assigning

Material supply trailer with compartments for standard small parts

work, preference is given, in accordance with the usual custom, to loaded and foreign cars, these cars and such light-repair home cars as can be completed in one day, being despatched the following night. Medium- and heavy-repair cars are switched to other tracks in the repair yard and two new cuts of cars set in on tracks 7 and 8.

As a result of an extensive study, the Chicago & North Western has set up a schedule, or conservative time allowance, for each detail operation entering into the repair of freight equipment, and given this operation a number for purposes of identification. The original-record cards carry a description of each repair operation, with columns for the operation number and time allowance, name of the workman who made the repairs and a record of the actual hours worked. By comparing the actual hours worked and the schedule time allowance, a measure is thus obtained of the efficiency of the individual workman or crew and while it is recognized that good workmen may sometimes exceed the time allowance on account of unforeseen difficulties, they will not do so frequently unless some conditions obtain which need to be remedied. Aside from the original-record card, essentially only three other forms are used on the North Western in checking the efficiency of repair operations. One of these, prepared by each assistant foreman, shows the number of hours each man in his gang works each day, over or under the schedule. By striking an average, the average performance of the entire gang for that day can be obtained. The second form shows similar information for each gang for each day in the month, and the third shows the hours over or under the schedule for the entire car-repair force for each day in the month. Some idea of what is being accomplished at the new repair point is indicated by the fact that in December, with 25 working days, the schedule time was exceeded on only 2 days and equalled on 1 day. The actual time was, therefore, less than the schedule time on 22 days, the aggregate difference totaling 306 hours.

Monthly efficiency meetings, attended by all supervisors, are held in the general foreman's office to discuss performance records, read important letters, consider various repair-track operations and make recommendations for improvement. Particular attention is paid to safety by constant daily emphasis on the part of the foremen, as well as by the large signs shown in several of the illustrations. Only five reportable injuries occurred during 1928.

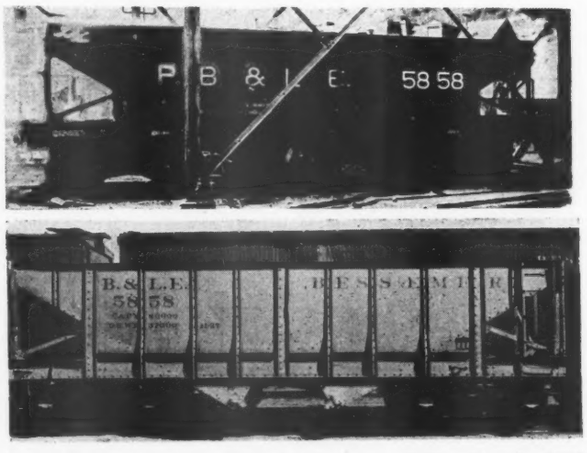
Repairs at Proviso Freight Transfer House

The Proviso transfer house for freight has an area of 21 acres. The building in itself is 1,420 ft. in length by 720 ft. wide, and provides a daily capacity of about 425 cars. Up-to-date equipment and facilities for handling freight in this house in the most economical manner have been provided, freight being transported from one car to another with gasoline-driven tractors hauling trailers.

The car department, appreciating the opportunity of conditioning equipment being loaded at this freight house while under protection from the weather, have provided full and necessary equipment for the light repairing of cars. The freight house tracks are piped and air supplied by an electrically-driven air compressor, maintaining 80 lb. pressure. Cars leaving the freight house daily receive an in-date air brake test, and cars having air brakes due for cleaning receive this attention. In a separate fireproof building, conveniently located, waste is renovated and returned to those journal boxes needing repacking. Particular attention is paid to the condition of draft gears, trucks and brake rigging. This practically eliminates terminal delays for air brakes and road delays for hot-boxes and coupler defects. Car repair work at the freight house is handled by a force of 43 men, including two supervisors.

The Chicago & North Western has under construction at Proviso at the present time a hump yard for the classifying of cars, which will also provide repair track with a capacity of 120 cars in the immediate vicinity. This additional repair point will handle light repair cars on the spot, avoiding the necessity of long haulage to the larger repair points. Plans are also being made to provide facilities for the washing of freight equipment.

* * * *



Top—Hopper car No. 5858 coming out of the shop in 1897; Bottom—The same car 31 years later—This car has been included in the permanent exhibit of the Bessemer & Lake Erie at its Greenville, Pa., shops

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Wheels Claimed Out-of-Gage on Account of Diagonal Bore

During December, 1926, and January, 1927, the Chicago, Burlington & Quincy removed wheels from four Kansas City Southern cars on account of cut journals and in each case applied new wheels. In all instances, one or both wheels were scrapped by the C. B. & Q. on account of diagonal bore and the K. C. S. was billed for the value of new wheels. The car owner contended that wheels condemned on account of a diagonal bore should be scrapped at the expense of the road responsible for the change of the wheels, according to Interpretation 6 of Rule 98. The C. B. & Q. contended that wheels out of gage may be removed from service at any time as an owner's defect and the disposition and credit is determined solely by whether such wheels can be retained and made fit for service under Rule 81; that in the case of the wheels in consideration, this could not be done and the responsibility for such wheels is chargeable to the owner and has no relation, whatsoever, to the remount condition covered in Rule 98, Interpretation 6.

The Arbitration Committee rendered the following decisions with the appended note: "The position of the Chicago, Burlington & Quincy is not sustained."

"Note: For the information of the members, your committee would advise that special investigations by representatives of the association failed to confirm the contention of the Chicago, Burlington & Quincy as to responsibility of car owners for the conditions in question. Some improper conditions were found to exist, such as slightly bent axles, eccentric boring of wheels, etc., which were of such nature that it is inadvisable to place the responsibility upon the owner in the event of wheel replacements made on foreign roads.

"Nevertheless, the improper conditions as found in connection with mounted wheels which had been withdrawn from service for various causes, were such as to justify calling the attention of all railroads and private car lines to the importance of all details of wheel and axle shop work.

"In connection with the Wheel Manual, which will be issued in the near future, it is urged that special attention be given to this line of work with a view of effecting desired improvement in the general situation."—*Case No. 1580—Kansas City Southern vs. Chicago, Burlington & Quincy.*

Joint Evidence Necessary for Claims of Wrong Brake Rod Repairs

On October 11, 1926, the Richmond, Fredericksburg & Potomac applied one bottom brake rod, 34 in. in length, to Chicago & North Western car No. 74179. The owner took exception to the repairs made because a 34-in. brake rod was substituted in place of the 32-in. rod which was standard to the car and not defective, therefore, making the repairs unnecessary. The repairing line pointed out that the reason a longer rod was applied was because of inefficient hand brakes and excessive piston travel which could only be adjusted by a longer rod, as the ordinary method of making an adjustment at the dead-lever guide did not provide sufficient takeup in the foundation gear to bring about a condition that would give proper piston travel and provide necessary force for the brake beams, claiming that the standard construction of the car had not been changed in any way.

The Arbitration Committee stated that "The bill of the Richmond, Fredericksburg & Potomac is sustained. If wrong repairs were made, joint evidence may be obtained upon return of the car to the home line."—*Case No. 1581—Chicago & North Western vs. Richmond, Fredericksburg & Potomac.*

Basis for Computing Depreciation of a Destroyed Car

Atlanta, Birmingham & Coast car No. 5056 was damaged, March 1923, on the rails of the Terminal Railroad Association of St. Louis and reported to the owner under Rule 120. The owner denied responsibility for the damage to the car and referred it to the Arbitration Committee, which decided that the car had not been properly reported under Rule 120, but was subject to Rule 112. Since that time, the respective companies have been unable to agree on the valuation of the car, or the date to which depreciation should be allowed. The handling line contended that the owner's claim should be confined to valuation on the basis of Class F, Rule 112, and depreciation allowed to October, 1924. The reason for placing the car in the Class F was the claim that the built-up draft members with which the car had been equipped, extended only 21½ in. back of the center line of the body bolster, instead of 24-in., as required by the A.R.A. rules for inclusion in Class E as claimed by the owner. The reason given for depreciating the car to October, 1924, instead of to March, 1923, when the car was actually damaged, was that the car had not been completely destroyed until the Arbitration Committee rendered its first decision in October, 1924. The owner contended that the car should be depreciated to March 6, 1923, the date the car was damaged, as the car had not been repaired after that date, nor did it render any service between that date and the date on which it was actually dismantled. The owner presented blue prints, which showed that the original construction of the car included draft arms extending 24 in. under the body bolster, which should place it in Class E.

The Arbitration Committee stated that "The car should be figured on the basis of Class E construction and depreciated to the date the car was regularly reported destroyed under Rule 112."—*Case No. 1582—Atlanta, Birmingham & Coast vs. Terminal Railroad Association of St. Louis.*

Failure to Secure Protection at Point of Interchange

On December 7, 1925, U.T.L.X. car No. 15590 was cornered in the yards of the Union Pacific, resulting in damage to the end running board. A new board was applied and a defect card placed on the car for three ½-in. running-board angle-iron bolts and two ½-in. sill-step bolts in place of the rivets. The car was delivered to the C. B. & Q. on December 11, 1925, and by this road to the owner on December 20, 1925, at which time inspectors of the U. T. C. Company and the C. & N. W. issued a joint inspection certificate reading as follows:

	Repairs Required	Nature of Defects
L side	Seven side running-board brackets straightened	Seven side running-board brackets bent
BL	One section of angle iron R. & R. and straightened	One section of angle iron bent
B	One end running board properly framed so as to fit angle iron	One end running board not properly framed to fit angle iron

On presentation of the joint inspection certificate, the Union Pacific acknowledged responsibility for the wrongly framed end running board, but declined to acknowledge responsibility for the bent brackets and angle irons. The U. P. pointed out that the running-board brackets mentioned on the joint inspection certificate were on the side of the car and had no relation to the running board that it applied. It did not acknowledge responsibility for the bent brackets and, therefore, the failure on the part of the C. B. & Q. to protect itself in interchange would release the repairing line of any reliability for defect-card protection under the interchange rule. Upon presentation of the joint inspection certificate, the C. B. & Q. requested rebuttal protection from the U. P., contending that the defects must have existed at the time the improperly framed running board was applied by the U. P. The C. B. & Q. further contended that the end running board and angle iron were damaged by cornering and the seven side running-board brackets were also on the same side of the car, and that it would not be possible to corner and bend the end angle iron with force enough to break the end running board without at the same time breaking the side running-board brackets.

In rendering its decision, the Arbitration Committee stated that "The contention of the Union Pacific is sustained. If delivering line defects existed at the time the car was interchanged, the Chicago, Burlington & Quincy should have protected itself by requiring a defect card at the point of interchange."—*Case No. 1584—Union Pacific vs. Chicago, Burlington & Quincy.*

Responsibility for Cost of Use of Steam Derrick and Tool Cars

During June, 1926, on authority of adjustment orders issued to the Cleveland, Cincinnati, Chicago & St. Louis by the chief joint car inspector at Cincinnati, a bill was rendered against the Louisville & Nashville covering the cost of adjusting loads on cars delivered at Cincinnati in bad order. The L. & N. objected to the bills because they included charges covering the use of a steam derrick and tool cars used with the derrick. The L. & N. requested cancellation of the charges for the derrick, claiming that under Car Service Rule 14 and interpretation of it, as set forth in Circular D-11-232, dated July 1, 1926, the C.C.C. & St. L. had no right to charge rental for the steam derrick and wrecker cars in making adjustments for the reason that the 10 per cent added to the labor cost and the wages of the craneman and helper operating the derrick is intended to cover all overhead charges. The C.C.C. & St. L. did not so understand the rules and their interpretation and contended that the rental of the derrick and wrecker crews was part of the performance of the adjustment. It did not concur that uniformity of practice on all roads in rendering a bill is desirable.

In rendering its decision, the Arbitration Committee stated that "The Committee has analysed the details of the charges rendered by the Cleveland, Cincinnati, Chicago & St. Louis and cannot find that any of them have been improperly made; therefore, the bills should be paid. Shop expense does not include the use of wrecking equipment.—*Case No. 1585—Louisville & Nashville vs. Cleveland, Cincinnati, Chicago & St. Louis.*

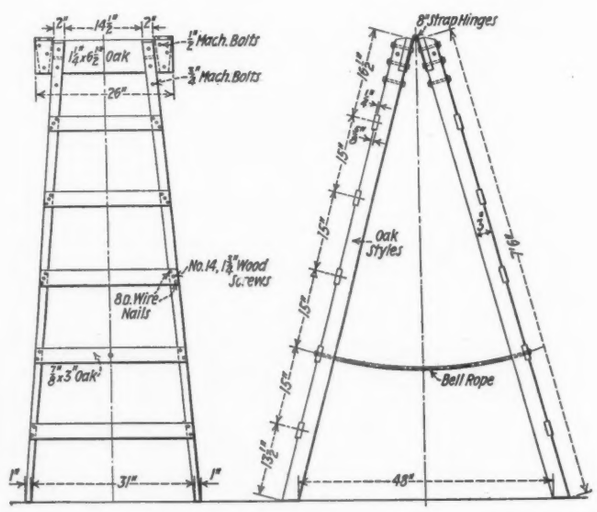
Information Furnished by Handling Line Indefinite

On November 26, 1926, P.T.X. car No. 4293 was repaired by the Central of New Jersey which billed the Pennsylvania Tank Line for the amount of $40.44. After repairs were made by the Central of New Jersey, the car was forwarded to the owner for further repairs. The owner contended that according to Rule 44, a comprehensive statement should have been given by the handling line showing how the damage occurred and, if this could not be done, the bill should be cancelled as it would be an indication that the car had been subjected to unfair handling and that the damage was not caused by wear. The handling line maintained that the car had not been subjected to any of the provisions of Rule 32 and that the condition resulted from worn center anchorage-bolt holes, allowing the cistern to shift on the underframe, and, because of the internal pressure of the load and slight shifting of the tank, the bolts had become worn and eventually sheared off under ordinary conditions.

In its decision the Arbitration Committee stated that "The information furnished by the handling line as to the cause of defects, type of construction, etc., is indefinite and does not meet the requirement of Rule 44. Therefore, the contention of the Pennsylvania Tank Line is sustained."—*Case No. 1586—Pennsylvania Tank Line vs. Central Railroad of New Jersey.*

Ladder for Freight Car Repairmen

THE step ladder shown in the drawing is standard for all of the freight car repair shops of an eastern Class I railroad. It is made of oak and the two styles are hinged together at the top with 8-in. strap hinges. The rungs of the ladder are spaced 15 in. apart, the first rung being 13½ in. from the bottom. A bell cord is used to prevent the styles from spread-

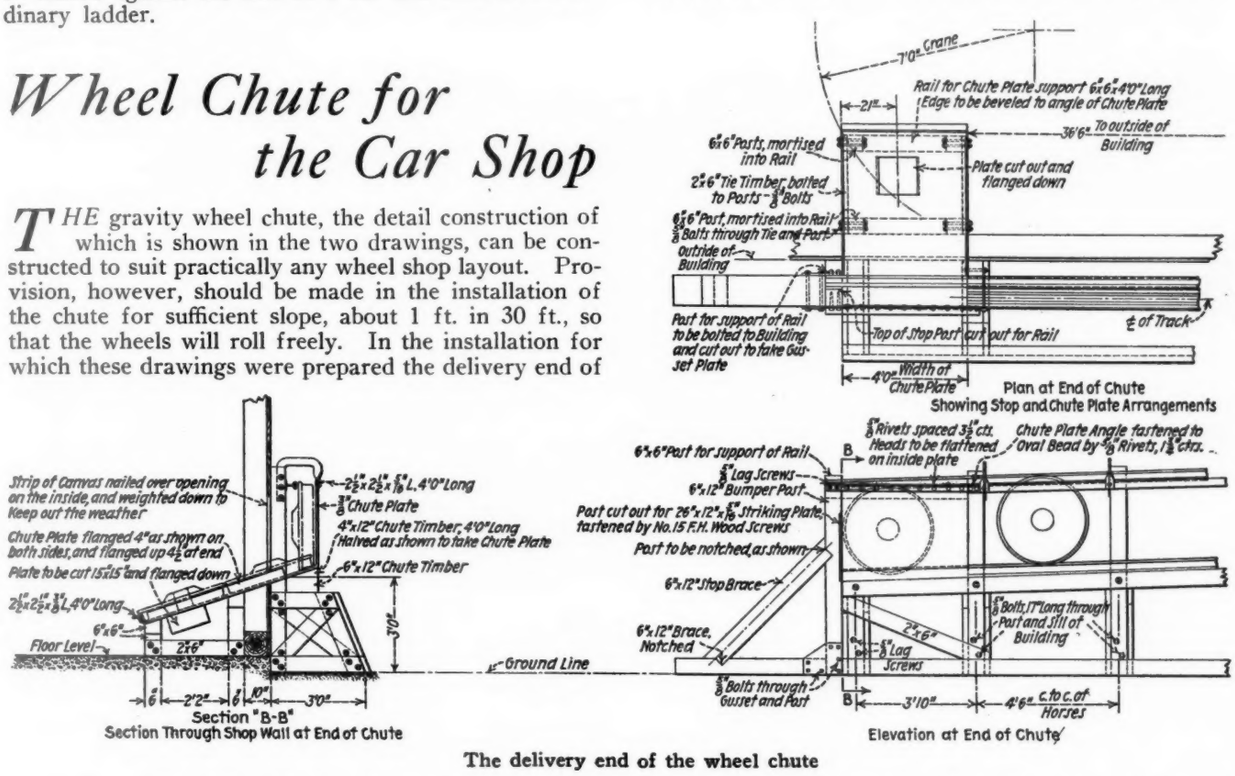


Standard step ladder used in the freight car repair shops of an eastern railroad

ing apart when the ladder is in service. This design of step ladder may be used to support scaffolding along the side of a car, or when folded together, can be leaned against the side of a car and used as an ordinary ladder.

Wheel Chute for the Car Shop

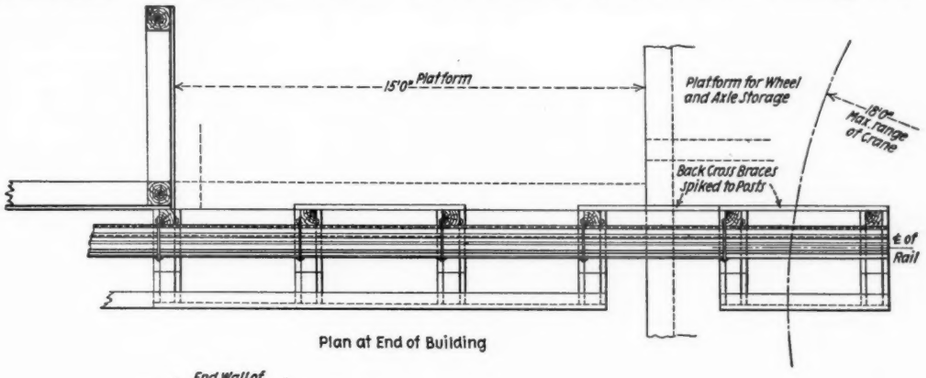
THE gravity wheel chute, the detail construction of which is shown in the two drawings, can be constructed to suit practically any wheel shop layout. Provision, however, should be made in the installation of the chute for sufficient slope, about 1 ft. in 30 ft., so that the wheels will roll freely. In the installation for which these drawings were prepared the delivery end of the chute extends through the wall of the wheel shop, the wheels being delivered inside the building.

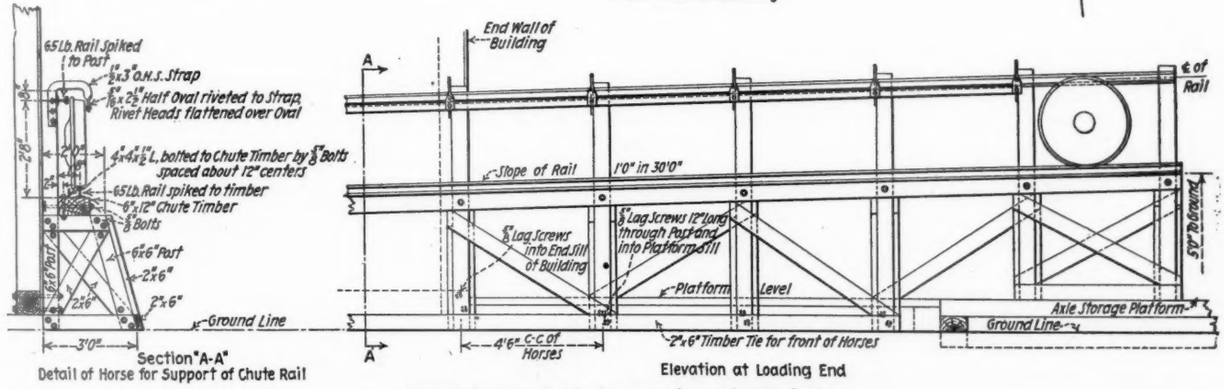

7'0" Crane
Rail for Chute Plate Support 6"x6"x4'0" Long Edge to be beveled to angle of Chute Plate
21"
36'6" To outside of Building
6"x6" Posts, mortised into Rail
Plate cut out and flanged down
2"x6" Tie Timber, bolted to Posts - 5/8" Bolts
6"x6" Post, mortised into Rail
5/8" Bolts through Tie and Post
Outside of Building
Post for support of Rail to be bolted to Building and cut out to take Gusset Plate
Top of Stop Post cut out for Rail
℄ of Track
4'0" Width of Chute Plate
Plan at End of Chute
Showing Stop and Chute Plate Arrangements
Strip of Canvas nailed over opening on the inside, and weighted down to keep out the weather
Chute Plate flanged 4" as shown on both sides, and flanged up 4½" at end
Plate to be cut 15"x15" and flanged down
2½"x2½"x5/16" L, 4'0" Long
5/8" Chute Plate
4"x12" Chute Timber, 4'0" Long Halved as shown to take Chute Plate
6"x12" Chute Timber
6"x6"
Floor Level
2'6"
7'0"
Ground Line
6" 2'2" 6" 10" 3'0"
Section "B-B"
Section Through Shop Wall at End of Chute
6"x6" Post for Support of Rail
5/8" Rivets spaced 3½" ctrs. Heads to be flattened on inside plate
Chute Plate Angle fastened to Oval Bead by 5/8" Rivets, 1¾" ctrs.
5/8" Lag Screws
6"x12" Bumper Post
Post cut out for 26"x12"x5/16" Striking Plate, fastened by No. 15 F.H. Wood Screws
Post to be notched as shown
6"x12" Stop Brace
6"x12" Brace, Notched
2"x6"
5/8" Bolts, 17" Long through Post and Sill of Building
5/8" Lag Screws
5/8" Bolts through Gusset and Post
B
3'10"
4'6" c. to c. of Horses
Elevation at End of Chute

The delivery end of the wheel chute

The chute consists essentially of two 65-lb. rails a running and a guide rail which are spiked to the timbers of a wood trestle. The wheel rolls on the running rail, alongside of which is a 4-in. by 4-in. by ½-in. angle, which serves as a guard to prevent the wheels rolling off the running rail to the inside. This angle is secured to the trestle by 5/8-in. bolts, spaced about 12 in. apart. The wheels are kept in vertical position by the 65-lb. guide rail and a 5/16-in. by 2½-in. half-oval bar which is secured to brackets, as shown in the drawing. These brackets are forged from ½-in. by 3-in. steel bar stock.

It will be noted that the oval bar extends only to the second post from the receiving end of the chute. A jib crane, having a maximum range of 18 ft., is provided at the loading platform for loading wheels on the chute. The wheels are placed on the running rail,


15'0" Platform
Platform for Wheel and Axle Storage
18'0" Max. range of Crane
Back Cross Braces spiked to Posts
℄ of Rail
Plan at End of Building


65 Lb. Rail Spiked to Post
5/16"x3" O.H.S. Strap
5/16"x2½" Half Oval riveted to Strap, Rivet Heads flattened over Oval
4"x4"x5/16" L, bolted to Chute Timber by 5/8" Bolts spaced about 12" centers
65 Lb. Rail spiked to timber
6"x12" Chute Timber
5/8" Bolts
6"x6" Post
2'6"
2"x6"
2"x6"
Ground Line
3'0"
Section "A-A"
Detail of Horse for Support of Chute Rail
End Wall of Building
A
℄ of Rail
Slope of Rail
1'0" in 30'0"
5/8" Lag Screws into End Sill of Building
5/8" Lag Screws 12" Long through Post and into Platform Sill
Platform Level
5'0" Ground
Axle Storage Platform
Ground Line
4'6" C-C of Horses
2"x6" Timber Tie for front of Horses
Elevation at Loading End

Receiving end of the gravity wheel chute

leaned against the guide rail, and guided by hand until the wheel rolls down the chute to the guide rail and half-oval bar.

The delivery end of the chute is provided with a sloping receiving platform floored with ⅜-in. plate. The guard rail, made of 4-in. by 4-in. by ½-in. angle bar, and the running rail extends to the edge of the delivery platform only. The floor plate is bent at the top edge of the platform, the top edge of the plate being secured to the top bracket. The wheel rolls off the end of the running rail onto the platform. The slope of the platform causes the bottom of the wheel to slide away from the vertical portion of the floor sheet, and the top of the wheel to fall in the opposite direction. Thus the wheel slides to the bottom of the platform with the flange up. The wheels are transferred from the receiving platform to the wheel press or boring mill by means of a jib crane, equipped with a pair of wheel tongs. A hole is cut in the floor of the receiving platform to permit the insertion of the tongs through the axle bore.

*Just a Hand Hold, But--!**

Don't be careless in repairing safety appliances

By F. R. Tincher
Car Inspector, C. B. & Q., Wymore, Neb.

THE proper application and maintenance of hand holds and sill steps is of such importance as to warrant the formulation by the Federal authorities of a set of regulations which govern the railroads as to how these appliances shall be applied to rolling stock. As an illustration of what might happen through carelessness and the violation of these rules, the following story was written. A railroad car is the principal character of the story.

The Story of the Broken Hand Hold

"As I stood on a siding on a cold December morning, little did I realize that a serious accident would occur in which I would be implicated. The next moment, as my thoughts were wandering, I heard a shrill whistle down the track and a locomotive came into view. The train came to a grinding stop on the track just opposite me, and I heard the conductor shout to the head brakeman to pick up the car at the elevator.

"In a few moments, I was being dragged down the track on which I stood and backed into the train. Things were moving fast but my next recollection was a shrill whistle and the long train of which I was a part, began to move.

"At the next terminal, while being switched by a careless yard crew, the trap was set which proved later to be so serious. While switching, the crew failed to shove me clear of an adjoining track and I was cornered, breaking one hand hold and bending another. As I was loaded with grain, a car inspector immediately sent me to the repair track.

"The next morning the repairs that were needed were written up by the car checker and the material ordered. Instructions were included to clear the bent hand hold.

"The man who delivered the material, instead of bringing the hand hold over and laying it down, hurled it some three-car lengths upon the frozen ground at my side. More careless work, for by doing this the hand hold, already brittle from severe cold, broke about one-half way through.

"The carman was in a hurry and did not notice the fresh break, supposing it to be good material. The new hand hold was placed on my side in this condition and the hand hold that was bent was pulled out with a bar to the proper clearance. The carman put the hand hold to severe strain, by clearing it with the bar, and cracked it at one of the legs. There the trap was completely set with two cracked hand holds. The carman did not take a second look to see what damage, if any, he had done in clearing the hand holds.

"I was pronounced O. K. off the repair track that night as ready for service. A short time later, a switch engine backed against the cars on the track on which I was standing and a 'hi-ball' was given.

"The next moment there was a strain as we began to move and a switchman swung on to my side, grasping the new hand hold with one hand and the straightened hand hold with the other.

"We had scarcely moved two hundred feet when both hand holds broke. The switchman was hurled to the ground with a terrible thud, breaking his collar bone and receiving several minor injuries.

"Alas, another casualty because of carelessness."

Suggestions for Maintaining Safety Appliances

Sill step work is likewise as important so it is important to re-inspect all hand hold and sill step work after the job is completed.

The following shop practice should not be overlooked in the application and inspection of safety appliances:

(1) All hand holds and sill steps should be of the required dimensions and without flaws before applying.

(2) All old bolts should be examined and tested as to the correct size and strength before reapplying.

(3) A new appliance should be applied at the proper location according to the United States Safety Appliance Law.

(4) All bolts and nuts should be tight and the end of the bolt well riveted over.

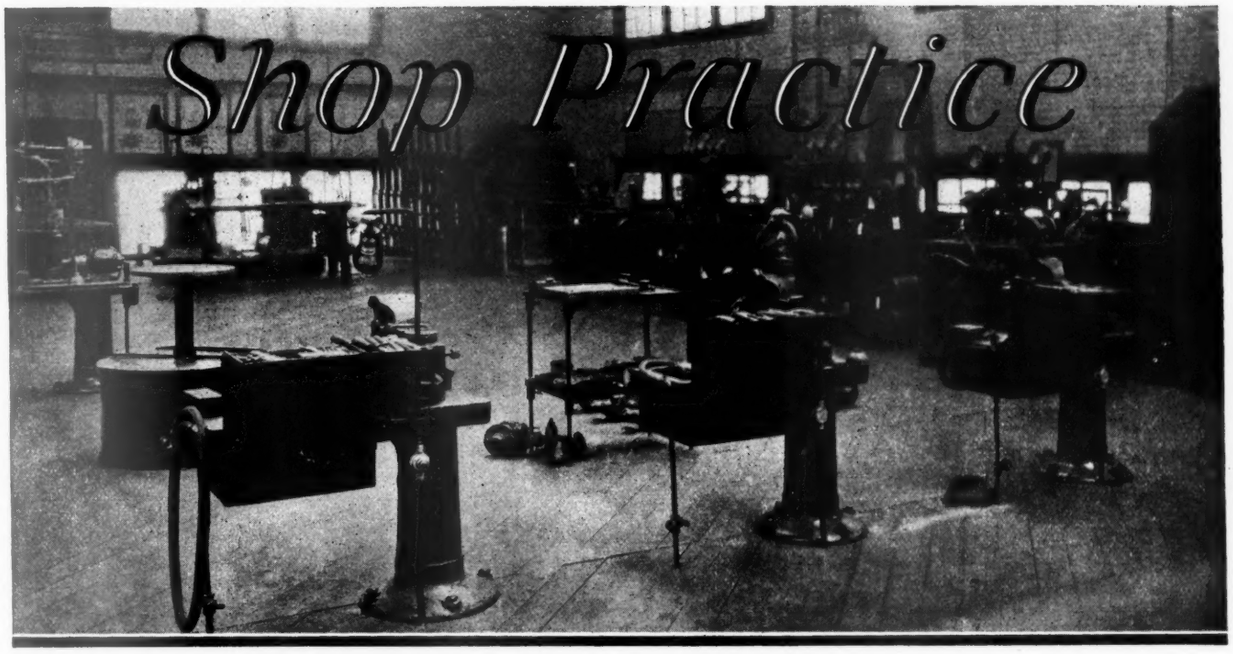
(5) All bolts and nuts should be visible if at all possible.

(6) All work should be re-inspected after completion to be sure that no damage has occurred in the application.

(7) Before leaving the car, determine that hand holds and sill steps are tight by turning all bolts connected with these items. In this way a great many bolts that have deteriorated with age will be broken before an accident has occurred.

* A paper presented at one of the carmen's meetings held each month at various points on the C. B. & Q.

RESEARCH in alloys of iron, to keep America abreast of world progress in industry, and described as the most ambitious undertaking ever attempted in this field, is planned by the Engineering Foundation in co-operation with the American Institute of Mining and Metallurgical Engineers, it is announced at the national headquarters of the Foundation, 29 West Thirty-ninth street, New York. Practically all industries, it is said, are affected. The initial task will be a critical five-year review of all available literature in English and other languages, resulting in a series of monographs and manuals, at a cost of $150,000.

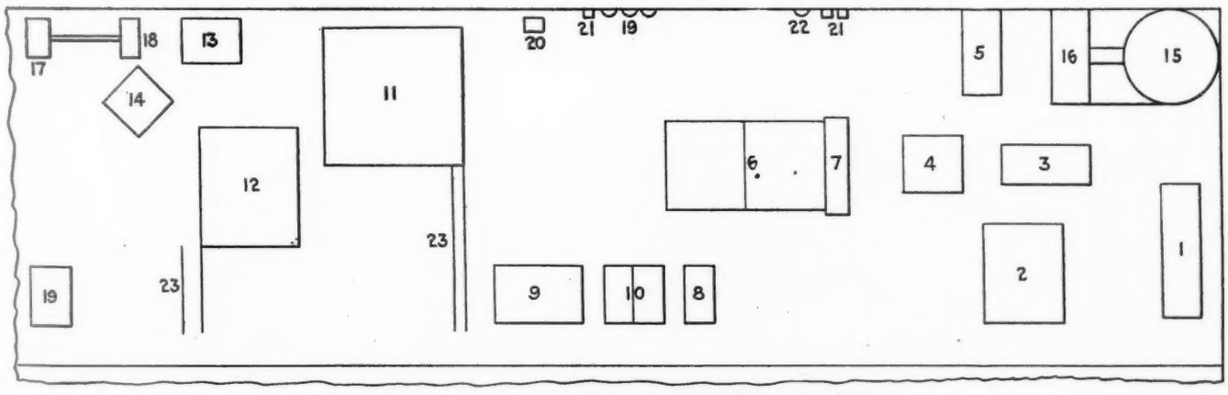


Spring Plant of the New Haven at Readville Shops

Equipped with pyrometer-controlled furnaces and electric salt bath to obtain uniform results

THE New York, New Haven & Hartford has recently put into service at the Readville locomotive and passenger car shops an up-to-date spring-testing plant for the manufacture and repair of all locomotive and car elliptical springs and for the repair of all coil springs for the system. Formerly all spring repairs were made at outside spring shops. New springs are now made by shop-order requisitions and delivered to the stores department for shipment to all points on the system.

The new shop has been planned to achieve three objectives: First, to control the physical characteristics of the spring steel during the process of manufacturing and repairing; second, the introduction of the two-heat system whereby the spring leaves, after passing through the forming press, are reheated before drawing, and, third, to obtain continuous production without backtracking.



Location of shop equipment in the Readville spring shop

Shop Layout

The spring shop, which is approximately 120 ft.

long by 35 ft. wide, is located in the southeast corner of the blacksmith shop. As indicated on the floor plan, the facilities are located so that the springs enter the shop at the door located near the hydraulic stripper (1) and are handled through the shop by electric monorail hoists until they reach the Tinius Olsen testing machine (12) located at the opposite end of the shop.

The shop is well provided with material-handling facilities. A one-ton Shepard electric hoist and two Ingersoll-Rand air hoists operate on a monorail which extends from a point over the band-stripping machine the length of the shop to a point over the testing machine. In addition to the monorail, four pillar and wall hoists are so located that each repair operation is served by hoists. Two of these hoists are equipped with Ingersoll-Rand air hoists and two with Shepard electric hoists. The location of these hoists can be determined from the illustrations.

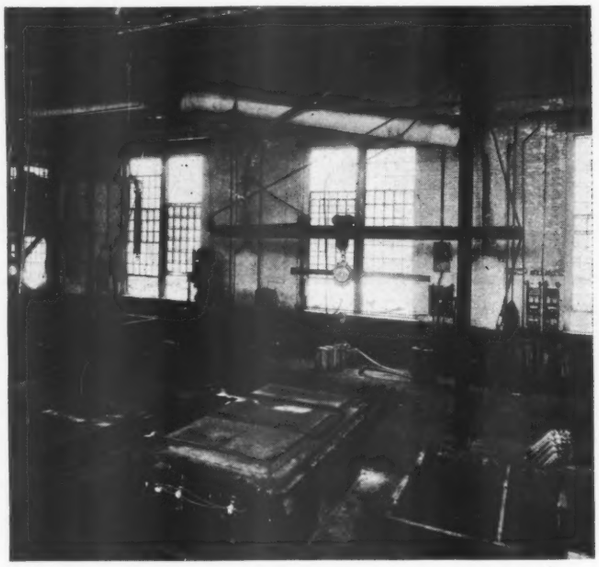
Since all of the machines are operated by hydraulic pressure, the shop has been equipped with a hydraulic accumulator system. A Southwark 10-in. diameter, 10-ft. stroke moving-cylinder type hydraulic accumulator, with a diameter of 10 in. and a stroke of 10 ft., has been installed, which acts as a storage reservoir for supplying hydraulic pressure of 1,500 lb. per sq. in. to the water lines connecting the various machines. The pressure is obtained by a Gould triplex-plunger pump operated by a General Electric 550-volt induction motor. At 850 r.p.m. the pump delivers 20 gal. per min. at 1,500 lb. pressure to the accumulator. The pressure is automatically controlled by an overflow tank. Welded pipe joints are used throughout to prevent leaks.

Table I—List of Equipment Installed in the Spring Shop at Readville

Tool No.	Name of Unit
1	Ryerson-Southwark 100-ton hydraulic stripper
2	Ryerson-Kling No. 3 guillotine bar shear
3	Ryerson-Ferguson 24-in. by 80-in. heating furnace
4	Ryerson combined double-end nibbing and trimming machine
5	Ryerson-Kling No. 7 hot punch
6	Ryerson-Ferguson standard two-section furnace
7	Ryerson No. 2 pneumatic Universal elliptic-spring former
8	Soluble oil-hardening vat
9	Westinghouse electric drawing furnace
10	Cleaning vats
11	Ryerson-Southwark triple-pressure hydraulic banding press
12	Tinius-Olsen 125,000-lb. testing machine
13	Oil-lubricating vat
14	Heating furnace
15	Southwark 10-in. dia. by 10-ft. stroke moving-cylinder hydraulic accumulator
16	Motor-driven Gould accumulator pump with automatic control
17	Griscom-Russell multi-whirl oil cooler
18	Oil pump for cooler
19	Steam hammer for making spring bands
20	Rockwell hardness tester
21	Switch boxes
22	Automatic pyrometers
23	Rail spring stands

The elliptic spring former located at one end of the two compartment furnace

A unique system has been devised to keep the quenching oil cool under continuous use. An 800-gal. oil-storage tank is located in the ground directly beneath the 400-gal. oil-quenching vat. The hot oil drains from the top of the tank into two 2½-in. outlet pipes, which connect with a 3-in. pipe that leads into the underground tank. From here the oil is forced to an overhead Griscom-Russell multi-whirl oil cooler by a centrifugal self-priming pump capable of delivering 250 gal. per min. against a total head of about 15 ft. The oil cooler consists of a tank inside of which is a spiral-shaped chamber which extends from end to end. The water inlet and outlet heads at the ends are connected by several tubes passing through a spiral chamber. Cold water is forced into the intake end and through the tubes, thereby cooling the hot oil surrounding the tubes in the spiral chamber. The cool oil flows by gravity back into the quenching tank. The system includes two strainers, one of which can be cleaned while the other is in service.



The upper end of the shop where the springs are reassembled and the bands put on

Method of Repairing Springs

On the band of each spring is stamped the date on which it was manufactured or repaired. All springs that have been in service less than two years and do not have apparent defects are cleaned and gaged and then passed through the lubricating vat (13), after which they are tested. If they successfully pass a 50-per cent overload test, they are put back into service. Blue prints, on which are listed the types of springs together with the normal working load, 50 per cent overload and the amount of allowable permanent set, are shellaced onto sheets of galvanized iron. Thus, the operator can quickly determine the test requirements for each type of spring.

All springs that have been in service two years or more are taken apart and repaired. The spring bands are removed from the old leaves by a 100-ton hydraulic stripper, after which they are picked up by a special lifting device designed so that the loose spring leaves

will not topple over while being carried to the heating furnace. Here the leaves are carefully examined for defects and gaged for thickness. The gage used is a hardened circular disc, around the circumference of which have been cut slots to correspond with the maximum allowable low limits of thickness for each type of leaf. The following table shows these limits:

Original thickness in.	Maximum low limit in.
.500	.483
.4375	.423
.375	.363
.3125	.303
.250	.243

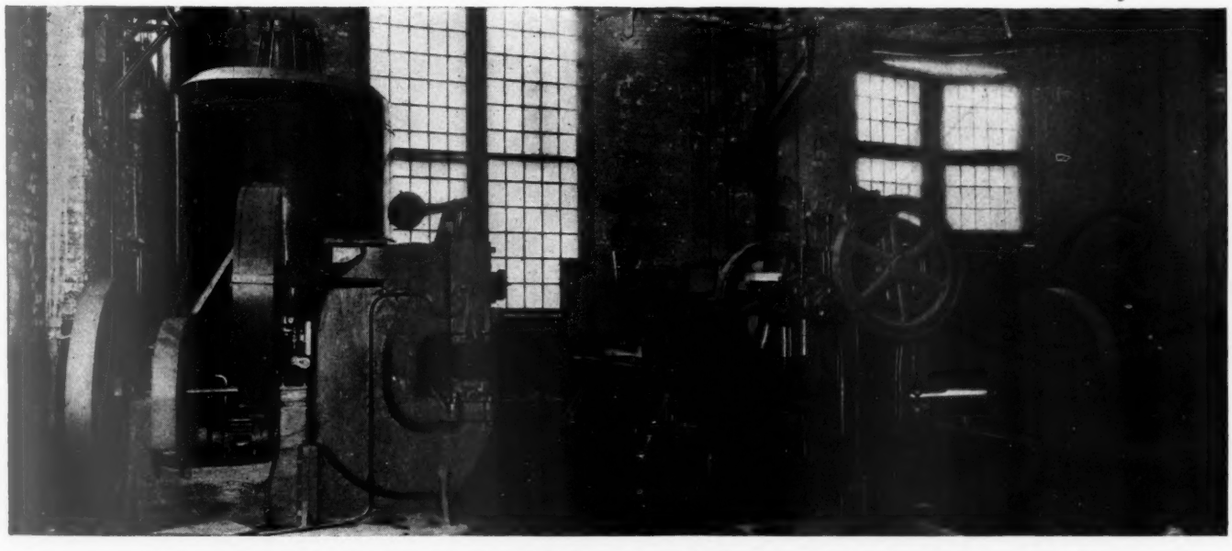
temperatures of these two furnaces are controlled by two Bristol automatically-operated pyrometers.

The spring leaves are placed edgewise in the heating furnace and allowed to remain until the pyrometers indicate a temperature of 1,750 deg. F. They are then removed and slid down a sloping apron, which leads to the pneumatic elliptical-spring former located at the rear end of the furnace, as shown in the illustration. The spring former, which has a capacity for 5/8-in. by 7-in. by 72-in. spring leaves, give the desired camber to each leaf by placing the hot leaf between a cold

Lett—Electric salt bath furnace; Right—Oil-quenching vat; Rear—Two-stage heating furnace

All rejected leaves are immediately replaced with new ones before the leaves are placed in the heating furnace. This furnace is separated into two heating chambers by a partition wall in the middle. One end is used for heating the spring leaves prior to the cambering operation and the other end is used for reheating the leaves after cambering to a temperature suitable for hardening. This furnace makes possible the two-heat system which eliminates the customary practice of cambering and hardening with one heat. The master leaf and a special flexible chain. A crosshead with adjustable supporting blocks to suit the master leaf forces the master leaf and the hot leaf against the chain and the resultant yield of the chain produces a curve on the spring leaf similar to the curve of the master leaf.

After this operation the leaves are passed along a roller conveyor located at the rear of the furnace and thence into the rear of the heat-treating furnace. They are allowed to remain in this furnace until a tempera-



Hot punch machine at the left and the double-end nubbing and trimming machine at the right

ture of 1,550 deg. F. is recorded, after which they are quenched in the soluble-oil vat located directly in front of the furnace door. This vat contains a self-draining basket, each end of which rests on the end of the piston

Lower end of the shop where the springs are dismantled

of a pneumatic cylinder which is controlled by a two-way valve. The basket containing the leaves of one spring is lifted by a special hook that catches under each handle and is placed in a hot Oakite cleaning solution to remove the oil before it is placed in the electric salt draw bath which is contained in a Westinghouse pot furnace. This furnace consists of a pot which is surrounded by electric heating grids heated by a 550-volt current. Two thermocouples are used, one making contact with the heating elements and the other with the salt solution. The thermocouples lead to two Brown pyrometers which automatically maintain the temperature of the salt bath to 750 deg. F. If the pot furnace is fully charged with 1,200 lb. of steel, a 10-deg. drop in temperature will result. The spring leaves are allowed to remain in the salt bath for 20 min., after which they are removed and allowed to cool in the air. The leaves are then immersed in a tank of boiling water to remove the salt incrustation.

The leaves are next properly assembled and moved to the triple-pressure hydraulic banding press which has a capacity of 33-, 67- or 100-tons pressure. The assembled leaves are pressed together and a heated spring band is slipped over them. The spring is then placed in the press where a band is forced down on the spring leaves under vertical and horizontal rams. The bands are stamped, indicating the type of spring and whether new or repaired.

The spring is next dipped into the lubricating vat to oil the leaves before testing. The system of testing is similar to that explained for testing springs that have not been in service more than two years.

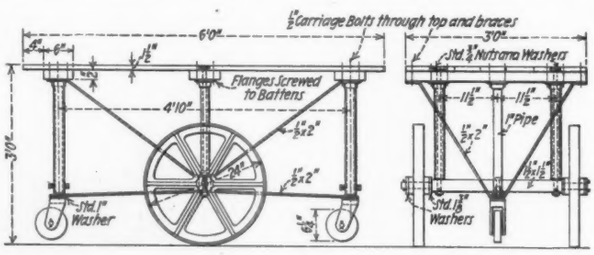
In addition to the Tinius Olsen testing machine, a Rockwell hardness tester is used to determine the hardness of the leaves. New and old heat-treated leaves are taken at random for hardness testing. The hardness ranges from 258 to 315 Brinell. The average hardness regularly obtained is about 300 Brinell.

Spring leaves are made for new and old springs. The machines and furnace for this work are located at the south end of the shop. The spring steel is first cut to length on the guillotine-type bar shear (2), after which the leaves are heated in the 24-in. by 80-in. furnace (3) for the nibbing and slotting operations. The springs are nibbed on the combined double-end nibbing and trimming machine (4), which also cold-trims the ends of the leaves to length. The hanger slots are punched in the leaves while hot on the hot punch (5). The leaves are then placed in stock ready to be included in a new spring or to replace a discarded leaf in an old spring.

With a force of six men employed in manufacturing and repairing springs, a total of 1,250 springs has passed through the shop during a period of 5½ months, working five eight-hour days a week. Two additional men are employed in making spring bands. With a gang leader, a total of nine men is employed in the shop.

Grease Cake Truck

THE truck shown in the drawing for hauling grease cakes to locomotives in the erecting shop, with the exception of the two cast iron wheels and caster wheels, may be made in the shop. The top and top



A shop-made truck for handling grease cakes

cross members or battens are of wood, secured to the pipe flanges by ½-in. carriage bolts, as shown. One-inch pipe is used throughout for the vertical members of the chassis. The pipe flanges are 1-in. by 4-in. cast-iron floor flanges. The braces are of 2-in. by ½-in.

steel and are welded to the lower end of the pipe. The axle is turned from 1½-in. by 1½-in. steel bar, the journal bearing having a diameter of 1-⅜ in. and a length of 4-⅝ in.

The caster is of forged steel and is held in position by two ½-in. hexagon bolts, the ends of which engage a groove machined in the caster pivot pin, which permits the caster to turn freely. The hexagon bolts are prevented from working loose by means of lock nuts. A ¼-in. oil hole is drilled in the pipe a short distance above the caster connection to provide for lubrication.

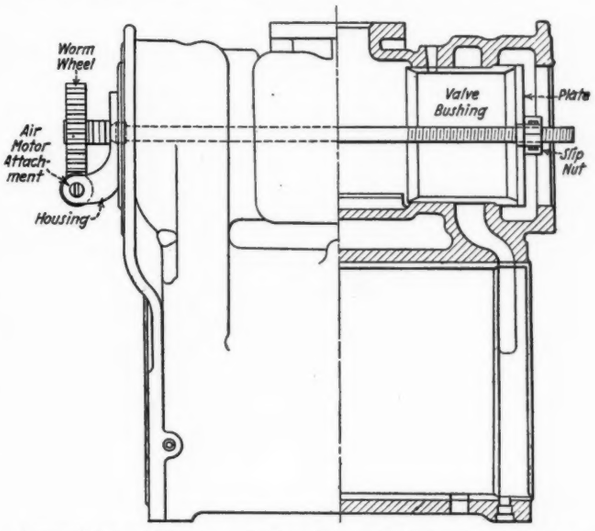
Applying Valve-Chamber Bushings

VARIOUS devices, either hydraulically or pneumatically operated, are used to apply valve-chamber bushings. Such devices usually require considerable time to set up and to make the necessary pipe or hose connections. The device, shown in the illustration, can be quickly set up and operated by one man. The average time required for applying a bushing for a 14-in. double-ported, low-pressure valve on a Mallet locomotive is about 30 min.

Referring to the illustration, the housing *A* is a steel forging which is machined to receive the worm with the worm shaft and bearings. The housing, which is drilled to suit the various classes of locomotives, is bolted to the cylinder-head studs. The end of the screw *B* is screwed into the end of the shaft *C*. The worm wheel *D* is keyed to this shaft with a $\frac{7}{16}$-in. by ⅞-in. steel key. The shaft is made sufficiently short so that the screw *B* can be disconnected when removing the device.

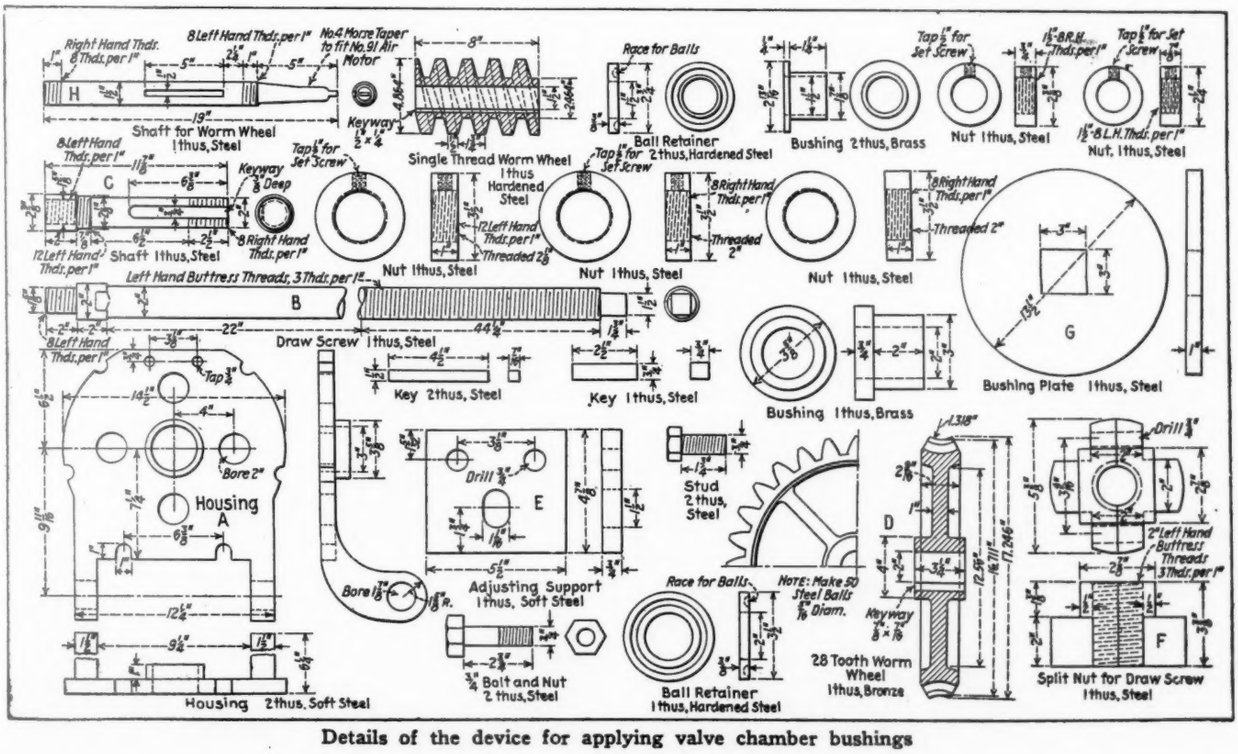
The adjusting-support bolts on the housing *A* take care of the larger sizes of valve chambers and bushings and make it possible to design the housing so that it will not be too heavy. The device is equipped with ball thrust bearings.

The square split nut *F* is made so that it can be placed on the screw *B* without having to run it up to the plate *G*. The bushing to be pressed in is placed in position



Assembled view of a device for applying valve-chamber bushings

and the housing *A* is clamped in place at the opposite end of the cylinder. The screw *B* is then connected to the shaft *C*. The plate *G*, in which is a square hole to fit the nut *F*, is placed against the face of the bushing and the split nut is entered in the square hole, after which the bolts holding the two halves of the nut are drawn tight. The air motor is connected to the Morse No. 4 taper shank on one end of the drive-shaft *H*.


Shaft for Worm Wheel 1 thus, Steel
Single Thread Worm Wheel 1 thus Hardened Steel
Ball Retainer 2 thus, Hardened Steel
Bushing 2 thus, Brass
Nut 1 thus, Steel
Nut, 1 thus, Steel
Shaft 1 thus, Steel
Nut 1 thus, Steel
Nut 1 thus, Steel
Nut 1 thus, Steel
Draw Screw 1 thus, Steel
Key 2 thus, Steel
Key 1 thus, Steel
Bushing 1 thus, Brass
Bushing Plate 1 thus, Steel
Housing A
Housing 2 thus, Soft Steel
Adjusting Support 1 thus, Soft Steel
Bolt and Nut 2 thus, Steel
Stud 2 thus, Steel
Ball Retainer 1 thus, Hardened Steel
28 Tooth Worm Wheel 1 thus, Bronze
Split Nut for Draw Screw 1 thus, Steel

Details of the device for applying valve chamber bushings

M-K-T Machine Methods on Crossheads and Pistons

Modern machines and special tooling equipment simplify the work and assure accuracy

ONE of the interesting departmental operations at the Parsons, Kansas, shops of the Missouri-Kansas-Texas is that of the piston, piston rod and crosshead department where the work is being handled by modern machine tools with the aid of many special tools and devices designed to assure the desired output and, at the same time, hold the work to close tolerances. This article will describe the details of the several operations on the three general classes of locomotive parts handled in this department—crossheads, piston heads and piston rods.

The standard practice of the M-K-T is to apply box-type pistons to cylinders under 24-in. diameter and the built-up type to cylinders 24 in. and over. On the built-up type rolled-steel spiders, cast-iron bull rings and gun-iron packing rings are used, the bull rings being riveted to the spiders. Piston heads, when new, are applied 1/32 in. smaller in diameter than the bore of the cylinder. When locomotives are given heavy classified repairs in the back shop, the standard practice is to renew all pistons that are worn $\frac{3}{16}$ in. below the bore of the cylinder. All pistons are fitted with three cylinder packing rings, the depth of the grooves being $1\frac{3}{16}$ in. in pistons for cylinders 24 in. in diameter and over, and $1\frac{1}{16}$ in. in pistons for cylinders under 24 in. in diameter. The width of the ring grooves in new piston heads is $\frac{3}{8}$ in. plus .005 in. The width of the cylinder packing ring is $\frac{3}{8}$ in. minus .003 in. All pistons are scrapped when the ring grooves are worn to 13/32 in. in width.

The M-K-T purchases rough-turned piston rods from outside manufacturers. The limit of wear on piston rods is established at $\frac{1}{4}$ in. below the original diameter. Piston rods that are 1/32 in. out of round or tapered are trued up by grinding.

The Machining of Crossheads

The crosshead is first set up on a Niles 36-in. boring mill and the back sides of the wings are faced. It is then transferred to a face plate near the boring mill by an overhead crane and laid out for turning the neck and boring for the piston rod fit. This fit is designed with a shoulder at the inside end, against which the piston rod

is drawn up tightly. The taper of the piston rod fit is ¾ in. in 12 in. The crosshead is laid out to insure keeping the clearance on the inside of the crosshead divided equally and to insure the wings of the crosshead being of equal thickness. The crosshead is then taken to a Cincinnati No. 5 milling machine where a taper mandrel is placed in the piston-rod fit. The mandrel is secured in a V-block designed for this purpose. The shoe fit is milled with a 5-in. shell mill. The inside faces on the crosshead for the front end of the main rod are machined with a 2-in. helical cutter.

The crosshead is then returned to the 36-in. Niles boring mill, faced on both sides and bored for the crosshead pin. The keyway for the dowel in the wrist pin is next slotted by means of the rapid travel on the head. The crosshead is then taken to the radial drill and holes are drilled in the inside wing for the crosshead shoe bolts. This is done by placing a jig that fits snugly over the milled edges of the crosshead to hold it central. This jig has holes with casehardened bushings to pilot the drill and a 31/32-in. drill is run through the inside wing only. The jig is removed and the holes are counterbored 1⅜ in. diameter and $\frac{7}{16}$ in. deep for the heads of the bolts. There are eight bolts in each crosshead.

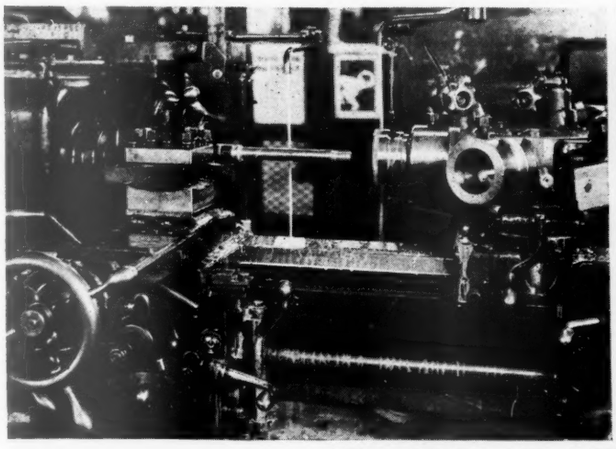
Bronze crosshead shoes are used, these being straddle-milled on a Cincinnati No. 5 milling machine while held in a fixture that accommodates two shoes at one time. The crosshead shoes are then taken to the radial drill and fitted to the crosshead which has previously had the holes drilled in the inside wing. The next operation is to run a 31/32-in. drill through the shoes and the outer wing of the crosshead. The holes are reamed with a 1-in. tapered reamer having a taper of $\frac{1}{16}$ in. in 12 in. to fit tapered bolts which are manufactured on a production basis and are placed in sets at the radial drill.

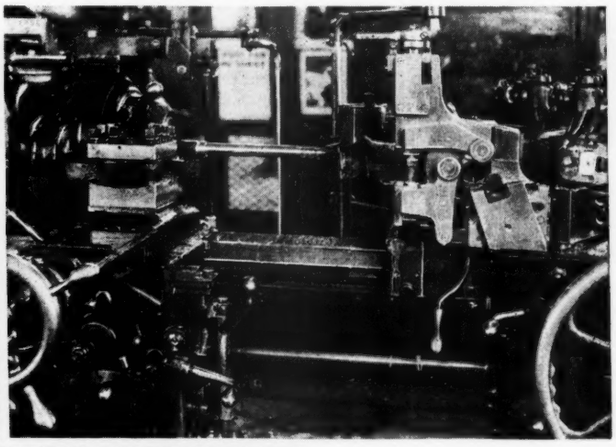
The next operation is to mill a keyway in the crosshead for the crosshead key. This is done on a Cincinnati No. 4 milling machine by setting up the crosshead at an angle of 45 deg. and drilling a 1⅛-in. hole through the neck of the crosshead. The keyway is milled in the crosshead by a 1⅛-in. helical cutter having a solid bearing in the center and a right- and left-hand spiral with the thrust toward the center of the crosshead. One of the illustrations shows the set-up of this cutter as well as the operation on the keyway. The cutter is supported by a center bearing which is secured to the overarm of the machine. This center support has an oil passage running through it, with an opening at the lower end that throws a stream of oil toward both ends of the cutter.

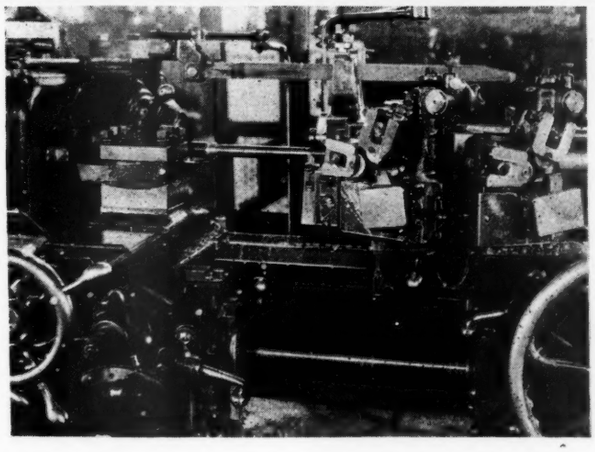
After the crosshead shoes have been applied to the crosshead and the eight tapered bolts fitted, the whole assembly is then placed on the same fixture on the No. 5 milling machine that was used for milling the crosshead shoe fit. The guide fit in the crosshead shoes is then milled by the use of a 4½-in. shell mill. The guide fit provides 1/32 in. lateral clearance as well as 1/32 in. vertical clearance.

The crosshead wrist pins are made from axle steel, annealed, sawed off to the proper length, roughed out, threaded and finished on an engine lathe.

The hexagon wrist-pin nuts are forged on a 4-in. heavy duty National forging machine. They are 3½ in. thread diameter and 5½ in. across the corners of the hex. Two nuts are used on each wrist pin. The forging blanks are produced on the forging machine at the

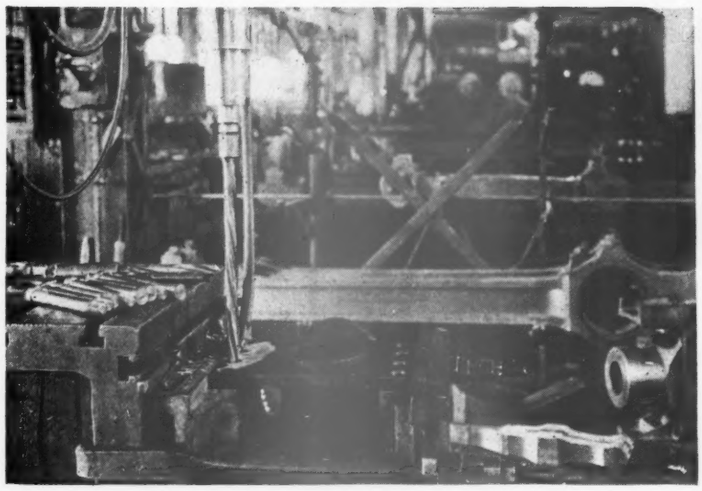


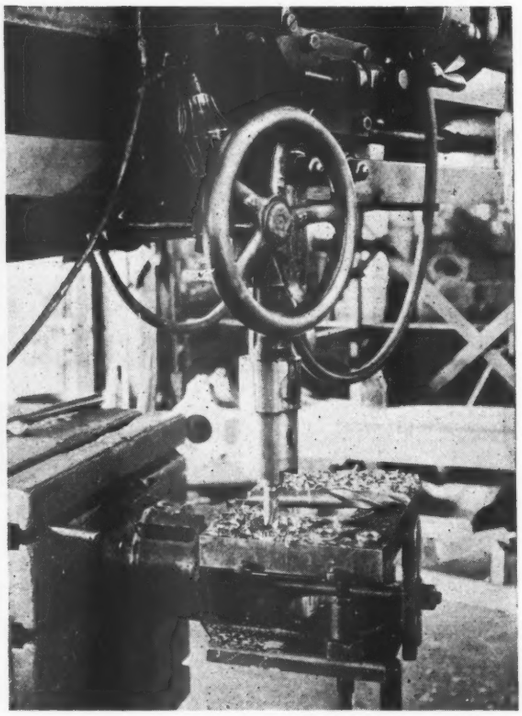




Three stages of the production work on crosshead-shoe taper bolts showing the turret-lathe tooling equipment

Above, right: End view of taper turning attachment— Left: Indexed for threading — Below: The taper-turning operation

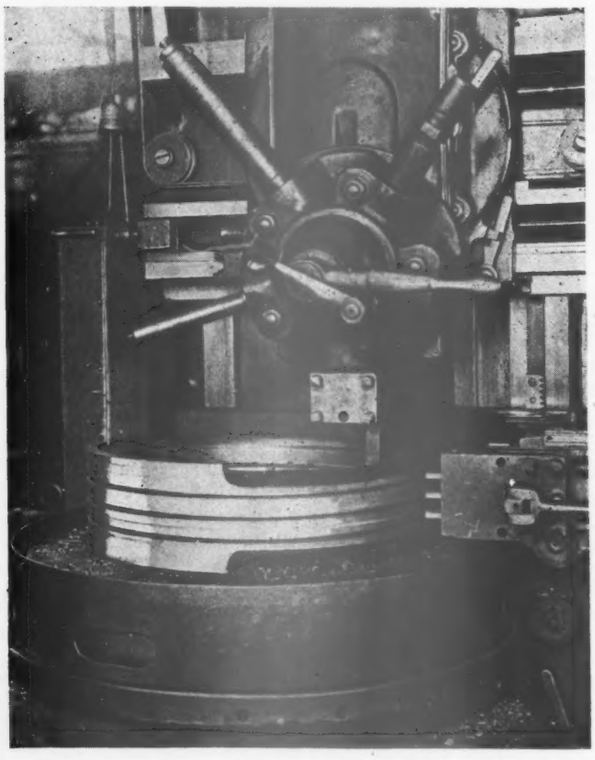




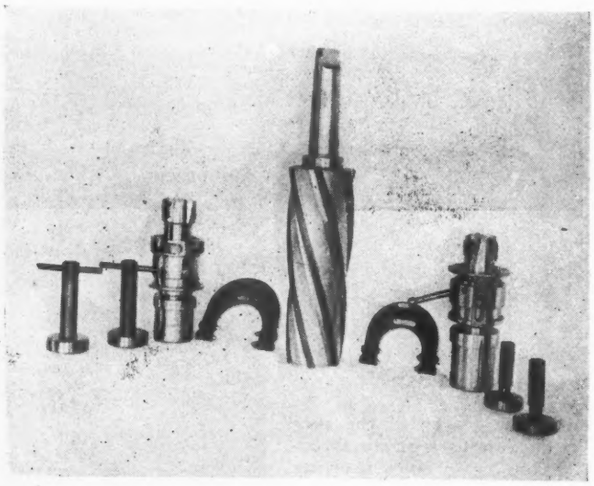
Above: Reaming the crosshead and shoes for tapered bolts. Right: Drilling the crosshead for the tapered shoe bolts

rate of 2½ min. per nut and they are finished on a 5-in. turret lathe at the rate of 10 min. for each nut.

As mentioned previously, rolled steel piston spiders are used on the heavier locomotives. These are finished on a 36-in. Niles vertical turret lathe. Special gages and templates are used to insure uniformity in the machining of the spiders. After finishing on the vertical turret lathe the spiders are then drilled on a radial drill by the use of a master ring that fits snugly over the spider and has hardened steel bushings to pilot the drill. There are 28, $\frac{13}{16}$-in. holes in each spider. The piston bull rings are made of cast iron and are machined on a Niles 36-in vertical turret lathe and are provided with three grooves for cylinder packing rings ⅜ in. wide which are cut with a gang tool at one operation, using a .015 in. feed.



Boring and cutting ring grooves in the bull ring



Special tools and gages used in the crosshead department

Left to right:—"Go" gage for threading 3½-in. wrist-pin and crank-pin nuts; "No go" gage for threading 3½-in. wrist-pin and crank-pin nuts; collapsible tap for threading 3½-in. wrist-pin and crank-pin nuts; "go" and "no go" gage for threading wrist pins and crank pins; inserted-blade sectional spiral reamer for wrist-pin holes in crossheads; "go" and "no go" snap gage for threading 3-in. wrist pins and crank pins, collapsible tap for threading 3-in. wrist pin and crank-pin nuts, "go" gage for threading 3-in. wrist-pin and crank-pin nuts; "no go" gage for threading 3-in. wrist-pin and crank-pin nuts

The bull ring is drilled with the same master ring that is used on the piston spider. This ring is designed in such a manner that it fits snugly into the inside of the

Table I—Time of Operations on Crossheads, Pistons, and Piston Rods

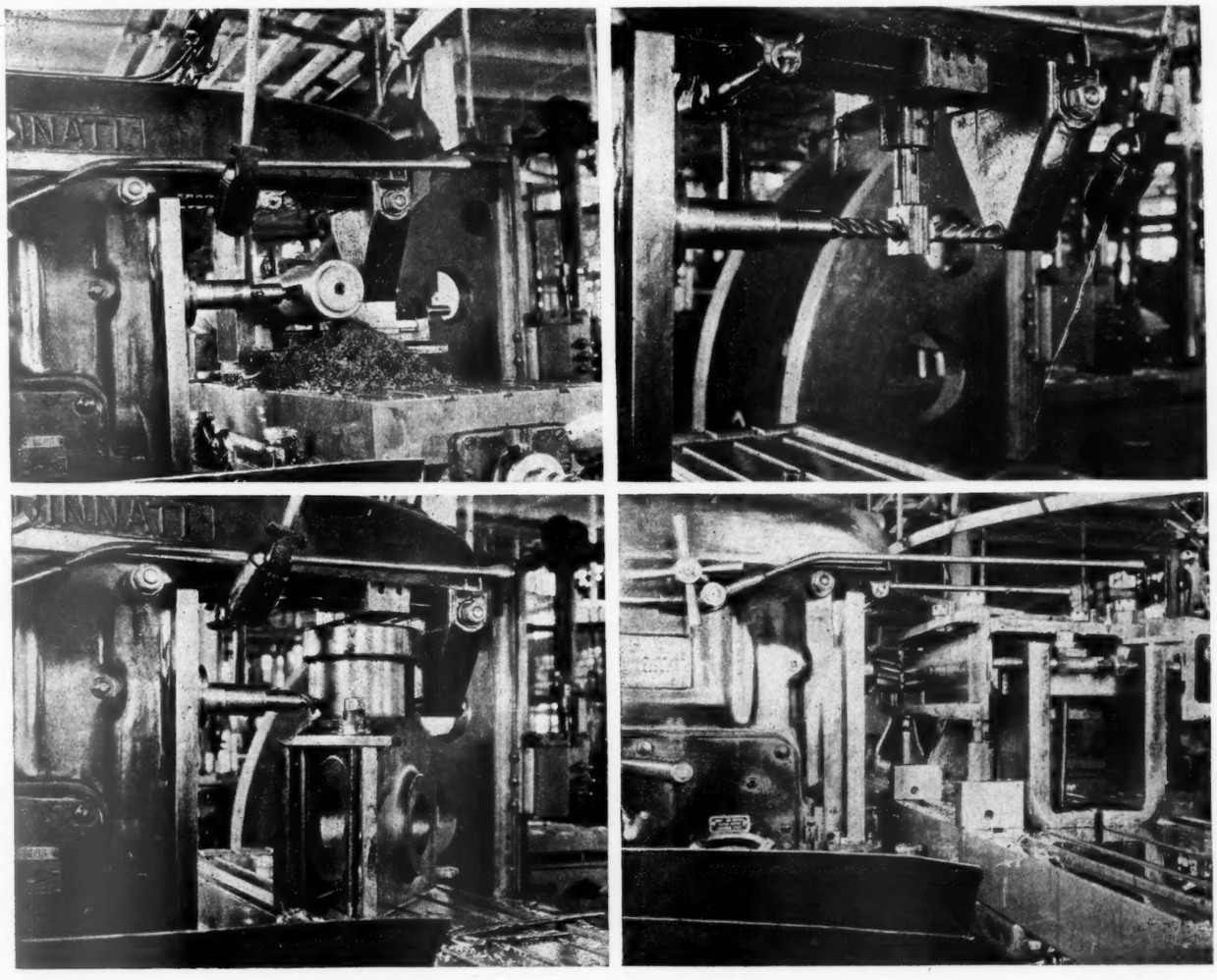
	Time required hr.	min.
CROSSHEAD		
Facing back of wings; layout for turning boss; Bore for rod fit	4	1 20
Milling crosshead shoe fit; milling inside faces for main rod fit	3	0
Facing both sides on boring mill; slotting keyway for wrist-pin dowel	3	30
Drill and counterbore inside wing	0	30
CROSSHEAD SHOE		
Milling two bronze shoes	0	12
Drilling and reaming shoes and outer wing of crosshead	1	45
Mill guide fit on both shoes	1	40
CROSSHEAD WRIST PIN		
Machined complete from forging	3	0
WRIST PIN NUTS		
Forging the blanks	0	2½
Facing both sides, boring and tapping	0	10
PISTON HEAD		
Finishing spider and boring for piston-rod fit	3	15
Drilling 28 $\frac{13}{16}$-in. holes in spider	0	28
Boring and turning bull ring	0	28
Drilling bull ring and countersinking for rivet heads	0	35
Piston packing rings, each	0	10
PISTON ROD (Purchased rough-turned)		
Turn, face ends, spider and crosshead fit, thread piston end	3	0
Mill keyway	0	25
ASSEMBLY		
Heat spider and apply to rod	0	20
Face spider for bull ring	0	20
Rivet bull ring to spider	0	30
Lap rod end into crosshead	0	30

spider fit. At the same set-up the holes in the bull ring are countersunk for the heads of the rivets and two $\frac{3}{8}$-in. holes are drilled for the dowels in the outside packing ring.

Piston packing rings are manufactured at the M-K-T reclamation plant at Parsons and are made of Hunt-Spiller gun-iron. They are manufactured on a vertical turret lathe and parted with a gang tool which cuts off four rings at once. The average time per ring is 10 min.

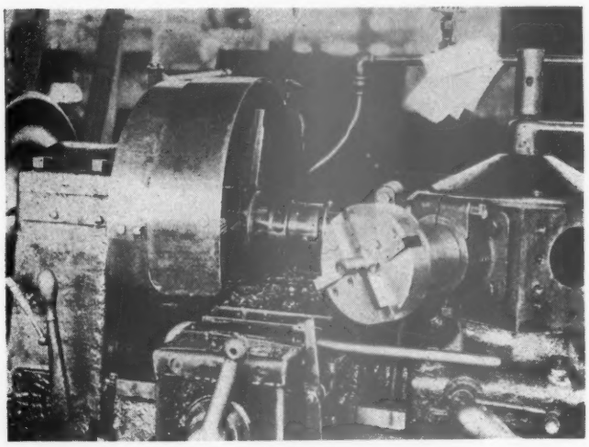
In Table 1 will be found a summary of the major operations involved in the work of this department, together with the time required to perform the work.

The taper crosshead shoe bolts previously mentioned are manufactured on a production basis on a Warner & Swasey 2-A universal turret lathe equipped with an automatic roller-rest taper-turning tool. The bolts are finished complete on this machine, which includes turning the entire length of the bolt, including the round head, threading the end and cutting off. Three of the accompanying illustrations show several stages of finishing these tapered bolts. One of the illustrations shows the overhead tapered guide bar which guides the lower turning tool. When this operation is completed, the guide bar is turned back out of the way as shown in the



Upper left: Milling the keyway in the piston rod—Upper right: Cutter set-up for milling keyway in crosshead; oil is played on the cutter through a passage in the center-bearing support—Lower left: Milling the keyway in the crosshead; the cutter set-up is shown in another illustration—Lower right: Special fixture for holding crosshead while milling shoe fit as well as guide fit in the shoes

other two illustrations. By the use of this attachment these crosshead bolts are finished complete in an average time of seven minutes and the diameter on the taper is held to limits within .002 in. The three illustrations

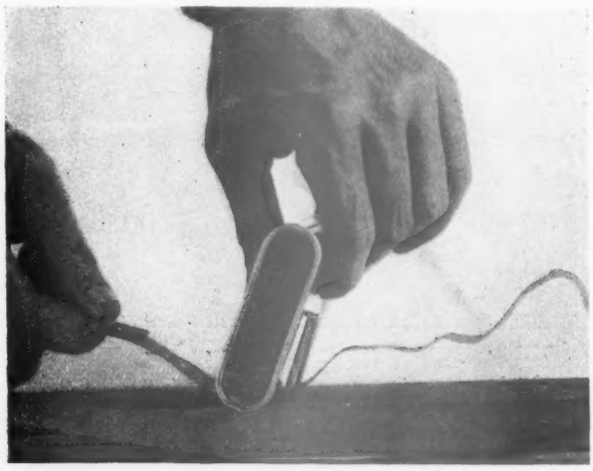


One of the four turret-lathe operations on wrist-pin nuts—Tapping the nut

are included not so much to show the sequence of operations in finishing these bolts, as to show the general design and arrangement of the tooling equipment used.

Smoothing Out Pipe-Lagging Bands

PIPE-lagging bands are often badly kinked when removed from around the lagging. There is a number of ways to smooth them out before re-applying those still suitable for use. The method shown in the



An easy method of smoothing out pipe lagging bands

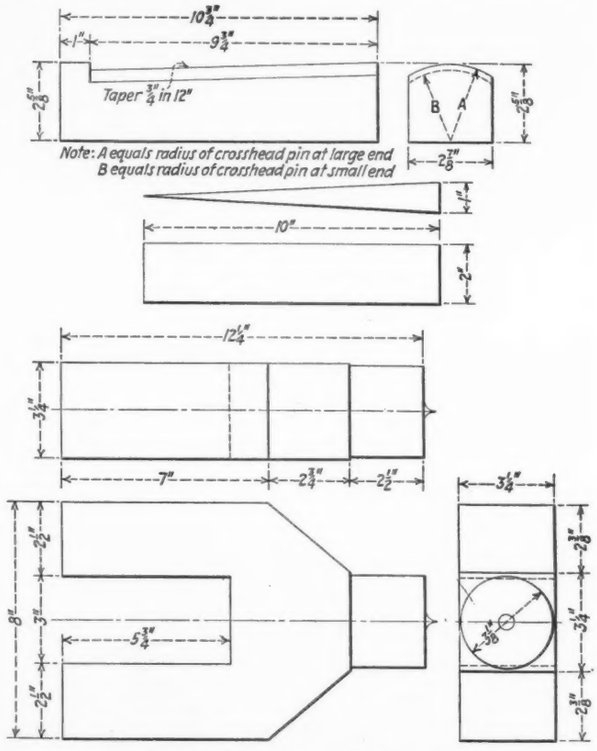
illustration is quick and practical. Drive two nails in a heavy piece of wood at a slight, backward angle and far enough apart to allow the lagging band to pass through. By using an empty tobacco can, as shown in the illustration, many bands can be quickly and easily smoothed out.

Separating Piston Rods from Crossheads

By H. E. Johnson
Apprentice Instructor, N. C. & St. L., Chattanooga, Tenn.

THE piston-rod puller shown in the illustration will quickly separate a crosshead from its piston rod with a minimum of effort and time. It consists of the puller, the key and the wedge.

After the crosshead pin has been removed, the crosshead is backed off from the front end of the main rod



Details of the piston rod puller

a sufficient distance to permit the puller to be inserted in the crosshead with the forked end toward the main rod. The key and the wedge are placed in the crosshead pin hole. By driving the wedge between the puller and the key, the key is forced against the crosshead and the end of the puller against the piston rod, which action separates the two parts.

THE FOUR BROTHERHOODS of train service employees have filed with the Interstate Commerce Commission a complaint requesting it to require the railroads to equip their cars within five years with automatic train-pipe connectors, stating that such devices have now been developed that will operate perfectly under all conditions and will eliminate casualties to employees now required to go between cars to connect air and steam hose.

Another complaint filed by the brotherhoods asks that the commission amend its order of March 13, 1911, so as to permit the use of metal running boards instead of wood running boards on box cars.

A Protection Against Oil Flash

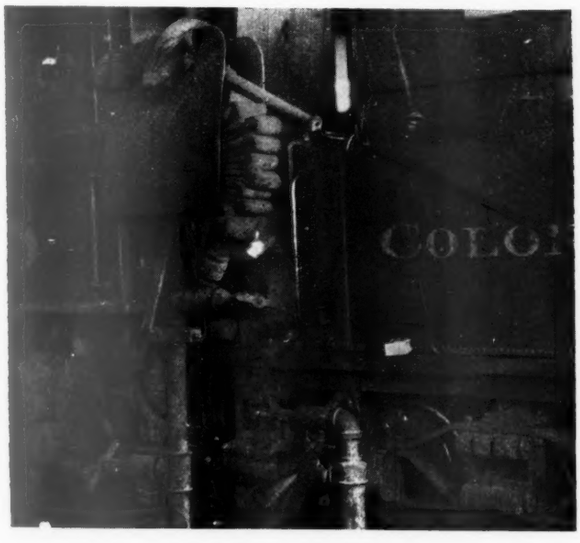
WHERE oil for starting fires, or other purposes, is piped into the enginehouse, and the connections are placed on posts between the stalls, a section of sheet metal, several inches square, should be nailed to the post to form a shield. A hole is cut for the pipe to pass through the shield which is bent parallel to the post and a few inches out from it. This saves the workman's face and eyes in case of a leak.

An effective way of shielding an oil pipe outlet located in an enginehouse

An Emergency Hose Rack

IN order that there may be a hose available in the enginehouse for instant use, a section is left connected to a hydrant between each pair of stalls. The hydrants are usually 4 ft. high and have two openings. The hose is connected to the upper opening and, when not in use, is folded up in a metal rack, which is placed above the hydrant.

The rack is 30 in. square and 6 in. wide, with two open sides. It is bolted securely to two 1½-in. by ⅛-in. straps, which in turn are clamped about the hydrant. Thus, the hose is always ready for immediate use, yet it is up out of the way. A section of canvas is used to cover the rack to protect the hose from dirt and possible damage.



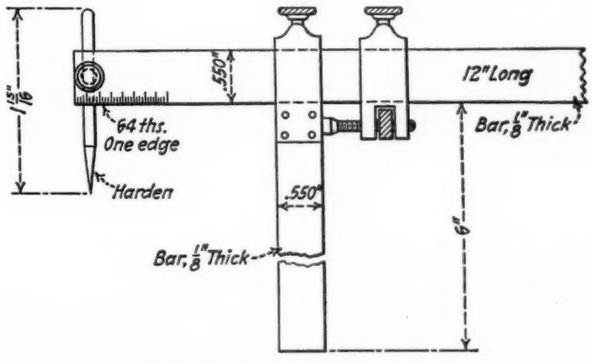
An enginehouse fire hose stored out of the way

Gage for Setting up Driving Boxes

By G. N. Cagle

Machine Shop Foreman, Central of Georgia, Macon, Ga.

SHOWN in the drawing is a parallel gage developed by C. R. Elder, Central of Georgia Locomotive shops, Macon, Ga., to facilitate the setting up of driving boxes to finish the shoe and wedge faces, and also for lining guides. The gage is made of tool steel and is capable of fine adjustments. The lower edge of the pointer bar is graduated its entire length to 1/64 in. Fine adjustment of the guide bar is secured by means of the thumb screw, as shown. This gage can also be used to advantage on several other locomotive repair jobs.



Driving box and guide gage

A NEW RECORD in fuel conservation by road locomotives was established by the railroads in 1928, according to complete reports for the year. An average of 127 lb. of fuel was required in 1928 to haul one thousand tons of freight and equipment, including locomotive and tender, a distance of one mile. This was the lowest average ever attained by the railroads since the compilation of these reports began in 1918, being a reduction of 4 lb. under the best previous record established in 1927. A new record was also made as to fuel used in passenger service, an average of 15 lb. being required to haul each passenger train car one mile, compared with 15.4 lb. in 1927.

The total fuel bill of the railroads for both road and yard switching service in 1928 amounted to $342,327,567, compared with $373,001,839 in 1927. The railroads used 111,572,184 tons of coal for both road and yard switching service. In 1927 the amount was 115,117,577 tons. They also consumed in road and yard switching service during 1928 a total of 2,442,790,701 gallons of fuel oil compared with 2,376,644,528 gallons in 1927.

The Reader's Page

An Apprentice Wants to Know

CHICAGO, ILL.

TO THE EDITOR:

Recently, my boss nearly fired me because I was going to allow a driving box to go back on an axle with the crown brass slightly loose in the box—just loose enough so that it could be noticed when struck with a hammer. A short time afterward I read a description of a floating bush driving box in which the bushing, when applied new, had a slack of 1/32 in. Goodness knows how much looser it would eventually get in service.

I have seen a great many side-rod bushings removed and scrapped because they were a little loose in the rod. That was when I worked in the rod gang. Now they are putting bushings in with 1/32 in. slack; that is, 1/64 in. small for the rod and 1/64 in. large for the pin.

What I want to know is the difference between a slightly loose crown brass and a very loose driving box bushing.

AN APPRENTICE.

The Mallet Type Locomotive

GALVESTON, TEXAS.

TO THE EDITOR:

A description of what was called a single-expansion articulated locomotive was published in the February issue of the *Railway Mechanical Engineer,* beginning with page 56. It is my opinion that the term "single-expansion articulated" does not serve to distinguish the locomotive from the several other types of articulated locomotives which are now in service all over the world.

The form of articulated locomotive which has found a permanent home in America, and to which the Northern Pacific locomotive belongs, is that which has been known since 1889 as the Mallet type. While the vast majority of such locomotives have been built with compound cylinders, examples of simple locomotives of this type appeared in America and South Africa 18 years ago. The distinctive feature of the Mallet type is its method of articulation, which is the same regardless of whether compound or simple cylinders are used.

The recent general employment of four simple cylinders in locomotives, such as the one you illustrate, has apparently started a campaign to eliminate the use of the word Mallet in connection with these locomotives, confining the name exclusively to those which have compound cylinders. No such distinction was made during the lifetime of Anatole Mallet. Now that he has passed away, why deny him the credit of devising a type of articulated locomotive which has been of inestimable benefit to American railways?

WILLIAM T. HOECKER.

Ground Frame Bolts vs. Reamed Holes

CHICAGO, ILL.

TO THE EDITOR:

An interesting article on page 153 in the March issue of the *Railway Mechanical Engineer,* describing the manufacture and gaging of taper frame bolts, briefly mentions the question of grinding the bolts and states that some shops have put this into practice.

It seems to the writer that unless it were possible to produce equally as perfect a hole as the ground bolt itself, it would be carrying refinement to an extreme and unprofitable degree unless it has been found possible to grind the bolts as economically as to turn them.

I have examined a great number of reamed holes and, no matter how accurately or with what care the reaming had been performed, they were far from being as good a job or as accurate as a well-ground bolt. Therefore, why go to the extra pains and expense of trying to fit perfectly ground bolts into less perfectly made holes?

I am willing to be shown that I am wrong in holding this opinion and would be pleased to have it discussed in your columns. Perhaps the representatives of those shops following this practice would be good enough to tell of their results.

CEMENT BLOCK.

"New" Arrangements of Walschaert Gear Not New

GALVESTON, TEX.

TO THE EDITOR:

The arrangement of the Walschaert valve gear, shown on pages 377 and 391 of the July, 1928, issue of the *Railway Mechanical Engineer,* certainly is not new. This arrangement was applied in 1913 to a 4-6-0 type locomotive built by the North Eastern at Darlington, England. This locomotive was also provided with uniflow cylinders and has been described in a number of English technical papers.

The "starting power lever" introduced into these gears simply adds three more joints to a mechanism that already possesses enough points of wear. Equally satisfactory results, as regards long valve travel, can be obtained from the conventional type of Walschaert valve gear, without any extra complications.

Several years ago, the Eastern Railway of France, built fifty 4-6-0 type locomotives having the ordinary design of Walschaert gear, with a maximum travel of 10½ in. These locomotives have done excellent work.

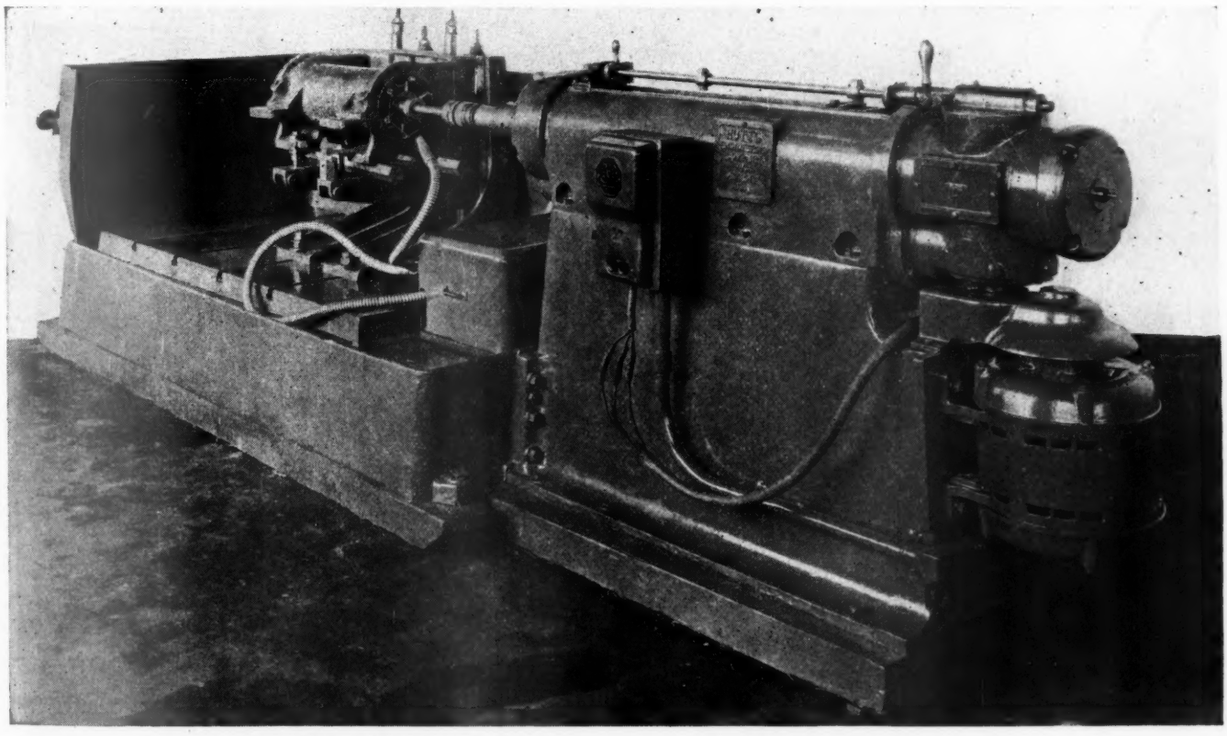
A READER.

Hutto Cylindrical Grinding Equipment

AS a result of several years experience in the manufacture of hone-type grinding equipment used in the automotive industries the Hutto Engineering Company, Inc., 515 Lycaste avenue, Detroit, Mich., has developed its Model MJ machine which is especially adapted to the finishing of such locomotive parts as air-brake cylinders, air-pump cylinders, firedoor operating cylinders and power-reverse-gear cylinders. The machine is of the horizontal-spindle type, the grinding tool being a six-stone hone operating at spindle speeds of from 100 to 200 r.p.m. The power for both the revolving and reciprocating motions of the spindle is furnished by a 7½-hp. motor operating at 1,800 r.p.m. The horizontal stroke of the spindle may be varied from five inches to a maximum of 27 in., making it possible to finish cylinders having a length of bore of 55 in.

One of the illustrations shows the machine set up to finish a 7-in. reverse gear cylinder, a job in which .015 in. of stock was removed in nine minutes and a limit of accuracy of .0005 in. maintained. As typical examples of finishing work on air-pump cylinders, it is said to be possible to remove .025 in. of stock from an 8½-in. cylinder in 12 min., and to remove .038 in. from a 14-in. cylinder in 40 min., while holding the accuracy of both bores to limits of .0005 in.

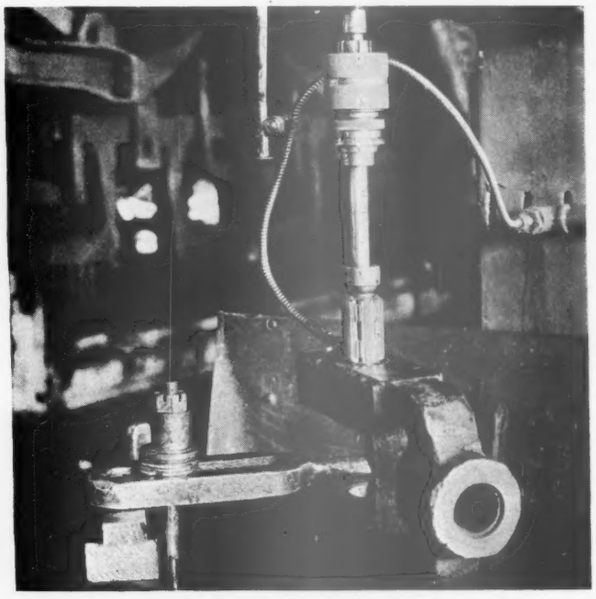
The Model MJ machine occupies a floor space of 4



Hutto Model MJ horizontal grinder set up to finish power-reverse-gear cylinder

ft. by 14 ft. and has a working table with a 30-⅝-in. by 65-in. available surface. The net shipping weight of the machine is 2,900 lb.

In addition to the above mentioned machine, which is designed primarily for work three inches or more in diameter, the company has developed a type of hone similar to that used for finishing automobile engine cylinders for finishing such smaller diameter work



Cylinder hone being used to finish bushing in valve-rod crosshead

as the grinding of bushings in locomotive valve-rod crossheads, combination levers, radius-bar pin bushings in the link block, and the eccentric-rod pin bushings in the link foot. One of the illustrations shows this type of grinding tool finishing 1-¾-in. valve rod crosshead bushings.

Both of these rod bushings are ground simultaneously with the Hutto grinder, which removes approximately .010 in. of stock from each bushing in 14 min. The bushings are finish ground to a plug-gage fit of 1.750 in.

Oxweld No. 21 Bronze Welding Rod

OXWELD No. 21 high-strength, bronze welding rod, which has been placed on the market by Oxweld Acetylene Company, 30 East Forty-second street, New York, is recommended for all bronze welding applications, including the fusion welding of brass and bronze, bronze-welding of malleable and gray-iron castings, joining dissimilar metals and building up bearings and other wearing surfaces. Because of its composition it has a uniformly low melting point and easily controlled flow. It produces a weld metal with a wear resistance as hard as that formerly obtainable with a manganese-bronze rod. By its use, tough and ductile weld metal having a tensile strength of over 45,000 lb. per sq. in. can be produced which is about 15,000 lb. per sq. in. in excess of the strength obtainable with earlier bronze welding rods. In addition, it will make a much stronger bond with ferrous metals.

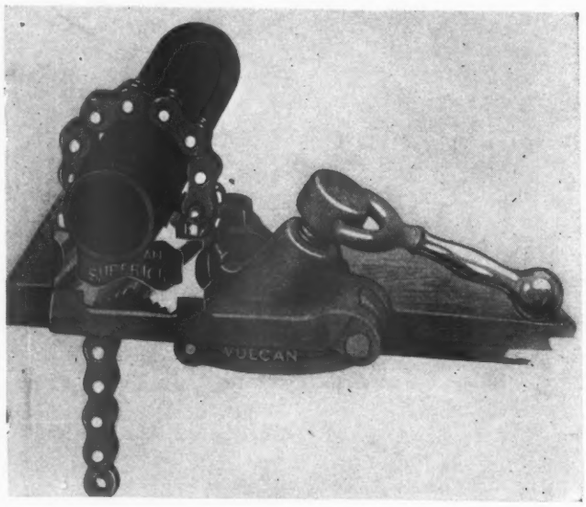
The properties of this rod eliminate almost all boiling and fuming of the weld metal. Annoying fumes

Bronze-welded 6-in. galvanized water line

are reduced to a minimum and the elimination of oxide and gas inclusions is given as the reason for both the remarkably sound and strong weld metal produced and the better adhesion to iron and steel.

Drop-Forged Chain Pipe Vise

THE Vulcan Superior chain-pipe vise, recently placed on the market by the J. H. Williams & Co., Buffalo, N. Y., includes in its design, two features which were not included in the original Vulcan vise.



Williams' Vulcan chain pipe vise

The vise is now provided with an overhead adjustment. The handle is on top, where it is easy to operate. Reversible jaws are provided so that when the teeth first in use wear, the jaw-holding bolts are removed and the jaws turned over.

The vise is made entirely of wrought steel. The base, jaws, handle and chainarm are made of drop forgings. The chains are claimed to be unbreakable, compact, rapid in action and are also positive in grip.

The vises are chromium-plated and furnished in two sizes for ⅛-in. to 4½-in. pipe.

Whiting Traveling Crane

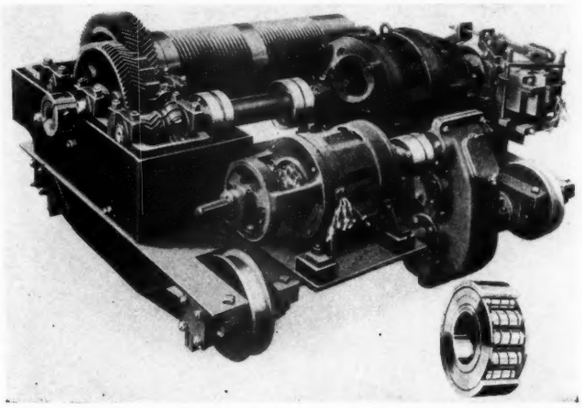
THE Whiting Corporation, Harvey, Ill., has developed a traveling crane, known as the Tiger crane, designed to permit more efficient handling of railroad material at less unit cost. One of the principal features of the design is the use of herringbone gears. These gears reduce noise, friction, power consumption and gear wear. Moreover, with them it has been possible to secure the necessary speed with two gear reduction instead of three, as ordinarily employed, permitting a design to be developed with fewer wearing parts and a much more compact trolley. Hyatt roller bearings are used at all important points in the crane construction.

To contribute still further to the efficiency and long life of the crane, its lubrication is made as nearly automatic as possible at all points. The entire hoisting mechanism, including the mechanical brake and drum gear, is enclosed in an oil-tight welded steel casing. The entire unit operates in an oil bath without danger of oil leaking out of the bearings which are inside the housing. The track or trolley-travel gearing is similarly enclosed and operates in an oil bath; likewise the bridge-travel gearing. Axle and squaring-shaft bearings are lubricated by a high-pressure grease gun.

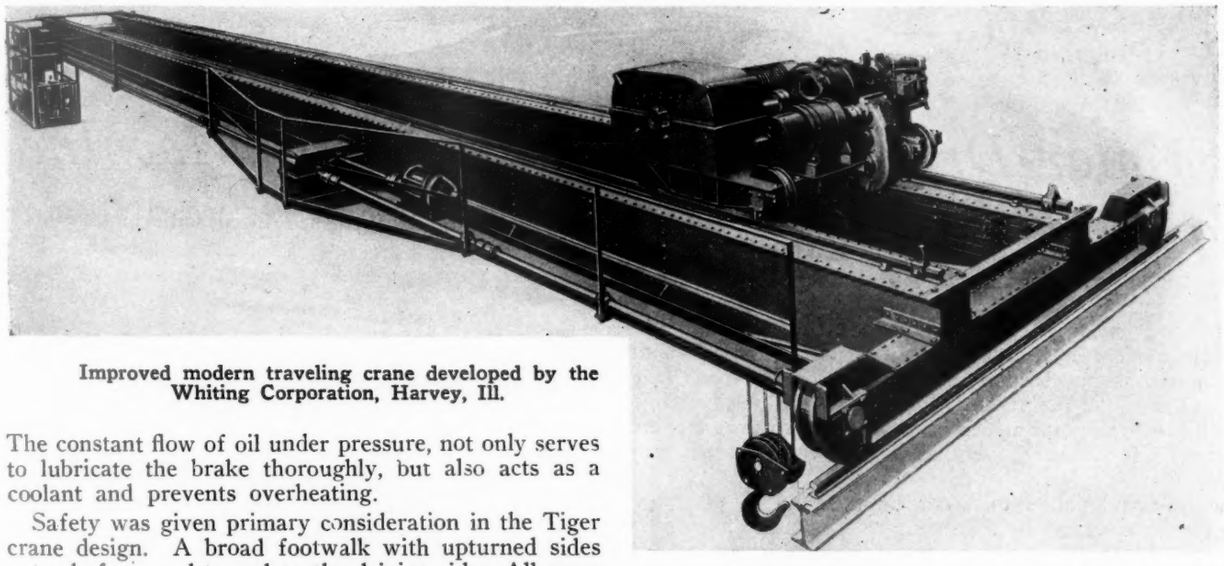
The unusual action induced by the meshing of the herringbone gears virtually gives an oil-pump action and results in oil being forced between the brake plates. The constant flow of oil under pressure, not only serves to lubricate the brake thoroughly, but also acts as a coolant and prevents overheating.

Safety was given primary consideration in the Tiger crane design. A broad footwalk with upturned sides extends from end to end on the driving side. All gears are enclosed; powerful automatic brakes are provided; an automatic limiting device prevents overtravel of the hook; the switchboard, with suitable locking device, is fully enclosed, and rail guards are provided for all wheels.

Special interest attaches to the arch-bar construction of the steel trolley frame. The structural members composing the frame are securely welded together, forming a one-piece construction of maximum strength and much lower weight than usual. A similar saving in weight, without sacrifice of strength, is obtained by the use of a welded steel casing for the hoisting mechanism. The hoist gearing and mechanical brake are mounted on a steel casting placed inside the welded gear case and bolted to the trolley frame. A close-up view of the bridge traveling unit with gear case removed is illustrated, showing the compact and accessible design, with all gears located at the center of the bridge.



Trolley complete with gear cover removed—View shows herring-bone gears and Hyatt roller bearings

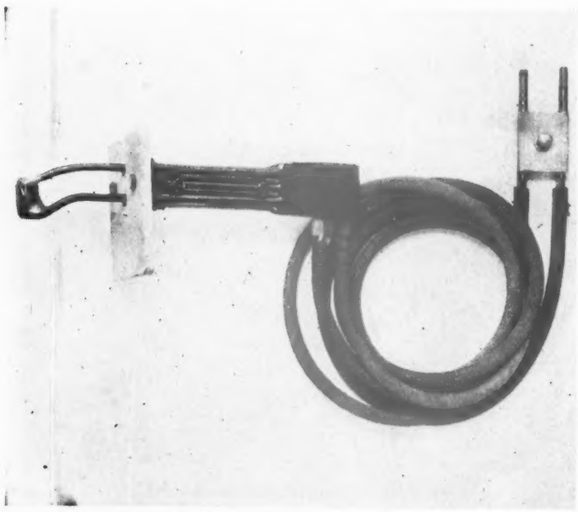


Improved modern traveling crane developed by the Whiting Corporation, Harvey, Ill.

TWO VACANCIES in the Frank Thomson scholarships, maintained for the benefit of sons of employees of the Pennsylvania will be open in June. The College Entrance Examination Board, 431 West 117th Street, New York City, will conduct the examinations. Applications from students already in college will be subject to the limitation that they must attain a mark of at least 50 per cent in all subjects in which they are examined.

Water-Cooled Carbon Electrode Holder

ANNOUNCEMENT has recently been made by The Lincoln Electric Company, Cleveland, Ohio, of the perfection of a water-cooled, carbon electrode holder for heavy-duty manual welding by the carbon arc process. Designed primarily to insure greater comfort and less fatigue for the operator, extensive tests in the manufacturer's plant indicate that the holder effects a marked economy in the use of the carbon electrodes.



Lincoln Type-W water-cooled carbon electrode holder

The design of the electrode holder makes it possible to weld with the arc tip of the carbon electrode projecting less than 3 in. from the carbon holder. Consequently there is less carbon area heated, thereby reducing the vaporization of the carbon. Thus it is possible to use smaller size carbons with higher current density. This is said to have effected a decided saving in electrode costs.

Many innovations in design have made it possible to produce a holder that weighs 3-¼ lb. in the operator's hand. In addition, the holder is well balanced and easy to handle because of the flexibility of the lead cable.

One of the unique features, which contributes to the light weight of the holder, is the use of the hose which not only carries the water but also the cable to the holder. Each of the two water tubes contains a small, light cable from the connector to the holder. The water flowing through the holder also acts as a cooling agent for the cables. By the use of water as a cooling agent the size of cable to the holder is reduced to a fraction of the size necessary if it were not used. For example if a standard cable were used, triple O cable would be necessary while, with the water cooling, only two cables each equal in size to number eight are used.

The carbon holder consists of coiled copper tubing through which water constantly circulates, the carbon electrode being inserted through the coil. The carbon holders are manufactured in sizes for use with ¼-in., 5/16-in., ⅜-in., and ½-in. carbons. A hand shield of compressed magnesium protects the operator's hand from the arc rays. The water cooling system is also incorporated in the hand grip of the holder to keep it cool.

Motor-Driven Universal Grinding Machine

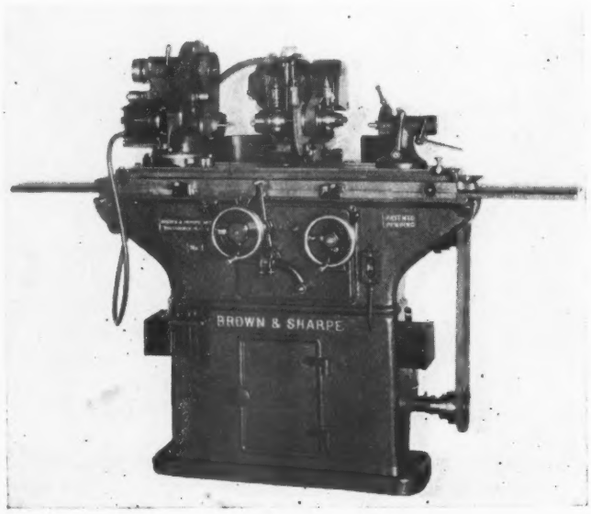
THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently added to its line of universal grinding machines the motor-driven No. 1 Universal grinding machine. It is similar in design to the belt driven No. 1 machine except that, like the motor-driven Nos. 2, 3, and 4 machines, it is equipped with three constant-speed balanced electric motors.

One of the features of this machine is the reversible wheel-stand motor which is reversed when the machine is used for internal grinding with the internal-grinding attachment. Hence, it is not necessary to swivel the wheel-stand platen to a reverse position. The motor may be reversed by a convenient lever and the spindle of the internal-grinding attachment is driven in the proper direction.

The base is cast in one piece, and is supported at three points. The bed is long in order to support the table at its extreme travel. The cross-feed slide is counterweighted to eliminate backlash and the pull may be reversed for internal grinding.

The motors are integrally mounted on the headstock, on the wheel stand and at the rear of the machine and are carefully balanced before the machine leaves the factory.

The machine is furnished fitted with motors only.



Brown & Sharpe motor-driven No. 1 universal grinding machine

Multi-Vane Grinder with Speed Governor

A *PORTABLE* pneumatic grinder, which is fitted with a speed governor to give power where it is wanted and yet keep the grinding wheel from operating at dangerous speeds, has been developed by the Ingersol-Rand Company, 111 Broadway, New York. It is designated as the Multi-Vane grinder.

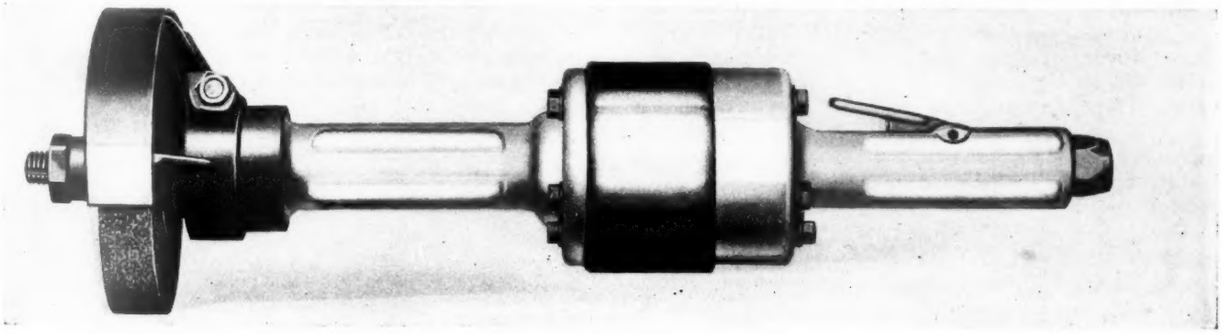
Any speed can be obtained by the governor up to 6,300 r.p.m., which permits grinding wheels of different diameters to be driven at their best cutting speeds. Standard machines are set at 4,200 r.p.m., which is considered the best speed for 6-in. vitrified and 8-in. elastic-bonded wheels.

A rotor with four power vanes is used. It is made of steel, hardened and ground to reduce wear, and has a full-floating fit on its arbor. This permits the rotor to aline itself between its two end plates so that no wearing pressure comes at the ends. The four power vanes balance the turning effort on the rotor, giving a smooth flow of power.

An exhaust deflector is used which also serves as a muffler. It baffles the exhaust air passing through it to eliminate noise. The deflector can be set to turn the exhaust in any desired direction.

The wheel end bearing consists of two radial-thrust ball bearings, placed to take thrust from either direction. Grinding on either side of the grinding wheel will, therefore, not destroy this important bearing.

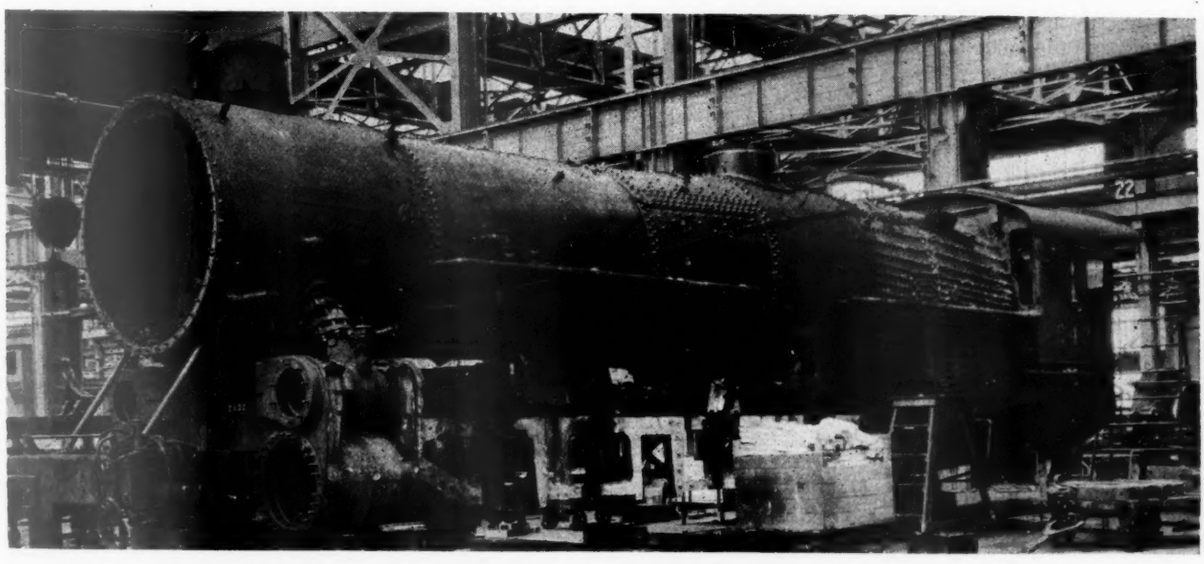
In the handle of the tool is an oil chamber, from which oil is automatically fed into the live air going to the machine every time the grinder is stopped and started. It keeps all wearing parts running on an oil film, thus reducing wear to a minimum.



Ingersoll-Rand multi-vane grinder

Multi-Vane grinders can be used for a wide variety of grinding, buffing, polishing, or cleaning work. When fitted with wire brushes they can be used for removing scale, rust, paint, etc., from steel surfaces. For this work, two types of wire brushes are furnished. A No. 28 cup-type wire brush is furnished for cleaning flat surfaces, and a No. 81 sectional wire brush for cleaning irregular surfaces, such as gear teeth, rivet heads, etc. Two types of handles can be furnished; a squeeze-type straight handle or an inside-trigger grip handle.

* * *



Modern shop equipment is necessary to economically maintain the present day locomotive

Indicator for Combustible Gases In Tank Cars

A PORTABLE instrument that detects immediately the presence of a wide range of combustible gases or vapors and indicates whether or not the atmosphere containing these gases is safe to breathe and safe for flames or fire, has recently been placed on the market by the Union Carbide Sales Company, 30 East Forty-Second street, N. Y. The device was first developed by the engineers of the Union Carbide & Carbon Research Laboratories, Inc., for the detection of methane, or fire-damp, in coal mines. The methane indicating detector has successfully passed the rigid tests of the United States Bureau of Mines and has received its approval as permissible equipment for use in methane and air mixtures. The combustible gas indicator is identical in construction except for certain modifications to make the instrument better adapted to the detection of numerous combustible gases which are encountered in many industrial fields.

The indicator utilizes the effect of combustion of flammable gas and air mixtures on the surface of a heated filament. This combustion increases the temperature and, consequently, the electrical resistance of the filament. This change in resistance causes the needle of a meter to move over a scale, from which the desired information relative to gas conditions is obtained.

The indicator consists of a detector head or combustion chamber, a meter case and a portable storage battery.

The detector head consists of a cylindrical metal case or bonnet which screws onto a metal base equipped with a short carrying handle. The bonnet is provided with louvres or small openings which permit the atmosphere being tested to circulate about the heated filament. Within the bonnet are three concentric gauze screens of a type similar to those used in flame safety lamps, which prevent the ignition of an external gas and air mixture. In the center of the chamber formed by these screens is the filament cartridge. The detector head is so constructed that incorrect assembly of safety screens and filament cartridge renders the circuit inoperative.

A flexible twin conductor cable about 50 ft. long connects the detector head with the meter case. The meter case contains the various resistances in the detector circuit, the indicating meter, the control switch and a rheostat.

A short flexible cable connects the meter case to the portable storage battery which supplies the power to operate the indicator.

The storage battery is carried on a leather belt worn around the waist. To this belt are hooked the detector head and coiled cable. The meter case is carried by a light strap around the operator's neck, or it may be hooked onto the leather battery belt if so desired. The entire outfit is compactly stowed in a carrying case from which it may be operated without removing the meter and battery from the case if preferred.

The indicator is made ready for operation by throwing the control switch first to the "Filament" position, then a few seconds later to the "Meter" position. Zero adjustment in fresh air is next made by turning the rheostat knob. The operator then places the detector head in the atmosphere to be tested and reads the meter. The detector head may be held in the hand, raised vertically or extended horizontally on a pole, or lowered by the cable into a manhole, tank, or elsewhere.

For the operator who desires to know the amount in per cent of a known combustible gas present in a mixture of that gas and air, the meter scale reading is taken and then referred to the particular curve or chart prepared for that gas. From the curve the operator reads directly the per cent of gas present corresponding to the scale reading of the meter. The gas charts are plotted with meter-scale reading as the horizontal axis and the per cent of gas as the vertical axis.

If an unknown mixture of flammable gases exists and the operator desires to know whether or not the mixture is explosive, the meter-scale reading is taken and referred to a "Per cent of explosibility" curve.

Simple combustible-gas indicator for determining the safety of the atmosphere in tank cars

Especially for those concerned with gas testing in and about oil and gasoline storage tanks and tank cars, the scale is also divided into a white section and a red section. If the meter needle comes to rest anywhere in the red section an atmosphere containing .2 per cent or more of combustible gas (expressed as pentane vapor) is indicated, showing that the atmosphere is unsafe to breathe without gas masks and unsafe for any work that requires heat or fire or is liable to emit sparks. If the meter needle comes to rest in the white section, less than the equivalent of .2 per cent of pentane is present, the atmosphere is safe to breathe without gas masks and hot repair work may be done, provided that all other regulations and precautionary measures have been followed.

LOCOMOTIVE FORCE FEED OILER.—Detailed and explicit instructions for the installation, operation and care of the "Genuine Detroit" Model A locomotive force feel oiler are given in catalogue No. 174 prepared by the Detroit Lubricator Company, Detroit, Mich. The catalogue contains 54 pages and is profusely illustrated with drawings showing various details of the oiler.

Tilting-Arbor Motor-Driven Saw Bench

THE principle of the tilting-arbor motor-driven saw bench, shown in the illustration, manufactured by the Oliver Machinery Company, Grand Rapids, Mich., is similar to the large type of tilting-arbor saw bench which was described on page 173 in the March, 1928, issue of the *Railway Mechanical Engineer*.

The table remains stationary and level at all times. The saw tilts for angle sawing and the angle of inclination is shown on a graduated scale at the front of the machine. The circular saw has the operating switch located on the front of the machine. The saw raises and lowers for changing the depth of cut. This allows the table to be located at the natural working height at all times and not raised too high for dado work and perhaps too low on other work.

The saw can be used in the crating department of almost any plant, in the cabinet departments, pattern shops and experimental departments. It is used to save the time of the big machines.

The machine is portable and operates from a light socket. It will cut 2 in. deep with a standard 7-in. saw or 2½ in. deep with an 8-in. saw. It will dado up to ⅞ in wide by 1½ in. deep. It will groove the same width and depth for ripping, beading, cutting tongue and groove; will cut compound miters in one operation, and will also do tenoning. It is universally used for sawing, ripping and cross cutting.

The table is 25 in. by 30 in. The machine is driven by a standard ½-hp. ball-bearing motor.

Oliver No. 191 portable tilting-arbor saw bench

Die Head for Threading Eccentric Stock

THE Landis Machine Company, Waynesboro, Pa., has placed on the market a new type of Landmatic die head for application to turret lathes and hand-operated screw machines. The head is designated as the F-type Landmatic.

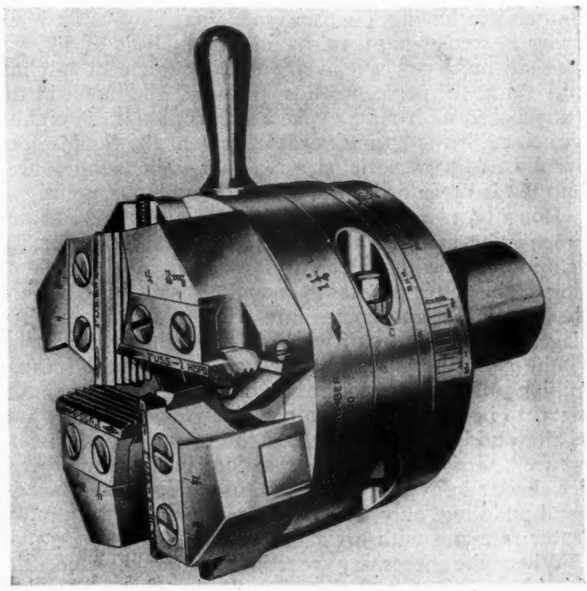
It was developed to meet the demand for a die head which would produce full and correct threads when the stock runs out of line, such as is the case when the stock is slightly bent, when the turret and spindle are out of alinement or when the gripping mechanism grips the stock off center.

The head floats or flexes on the shank, which allows it to center itself with the stock so that it produces a full thread even though the stock revolves eccentrically. The flexible condition is controlled by two heavy springs, which always return the head to the central position when it is not necessary to be off center.

The locking mechanism is independent of the shank and floats with the head proper. The driving torque is transmitted directly from the shank to the head body and is also independent of the rest of the head. It is opened automatically by retarding the forward motion of the carriage and is closed by hand.

The chasers are supported on the face of the head, which insures a maximum of chip clearance and a convenient access to the chasers when it is necessary to remove them from grinding.

The head is made of carbon steel, which is heat-treated throughout and ground. The adjusting worm is under proper turning tension at all times, which eliminates the necessity of locking it after each adjustment for size.

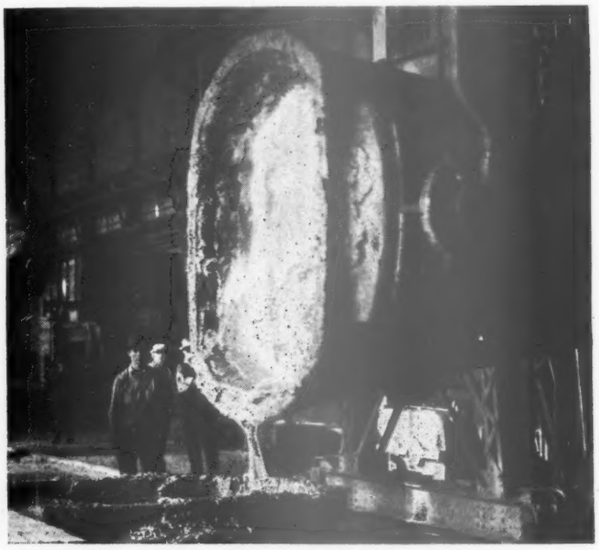


Landis F-type Landmatic die head for cutting correct threads when the stock revolves eccentrically

Aston Process for Producing Wrought Iron

A *RECENT* development in the process of manufacturing wrought iron for pipe, which, it is expected, will increase production, reduce the price of the commodity, and at the same time improve the quality of the production, has been worked out to completion by the A. M. Byers Company, Pittsburgh, Pa. This is known as the Aston process.

In the old process of manufacturing wrought iron, there were three essential steps: The melting of the ore or pig iron, the refining of the iron, and finally, impregnating the iron with a slag of the correct chemical properties. All of this was done in the one furnace.



Pouring off the slag before dumping out the puddle ball

In the new process the melting of the pig iron is done in a cupola having a capacity of about 20 tons an hour, using Bessemer pig iron, having an analysis of 1½ per cent silicon, 1 per cent manganese, .05 per cent sulphur, and .08 to .10 per cent phosphorous. The metal in the cupola absorbs from the coke a small amount of sulphur, and since this is an undesirable element the liquid metal is subjected to a special slag reaction while being poured into the ladle, in order to reduce its sulphur content.

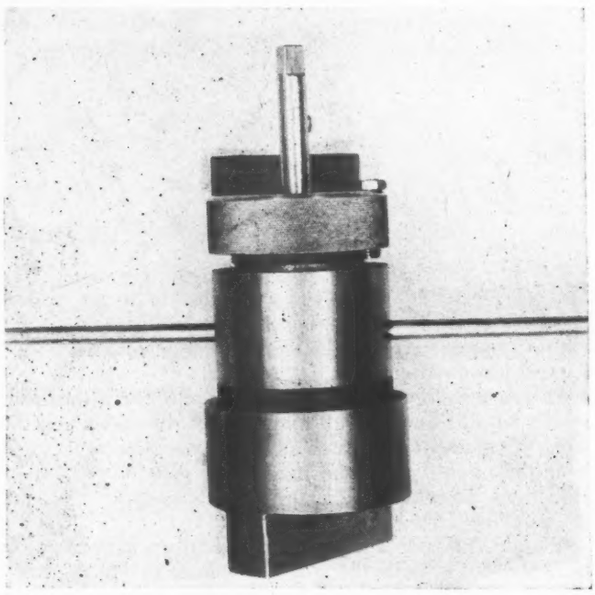
Roughly, about two tons of metal are tapped at one time. The metal is then poured into a converter for refining, following which it is poured into a bath of slag. This latter process is known as "shotting". When the stream of iron comes into contact with the molten slag, the temperature of which is below the melting point of the iron, the gases liberated as the iron cools cause millions of tiny explosions, which, in turn, cause the metal to be broken up into pea-size globules, exactly as in the puddling furnace when the metal is "coming to nature". It is said that the reactions in the new process are similar in every respect to those which take place in hand-puddling, only that they are completed at a much faster rate and with great uniformity.

When the necessary reactions are completed, the thimble is raised and tipped until the excess slag has been poured off. The material remaining in the bottom of the thimble is called the sponge, from which a spongy ball is formed, weighing approximately 2,200 lb. This spongy mass has a cross-section of 12 in. by 14 in., and a length of 5 ft. The composition of the material in this spongy mass is exactly similar to that in the ball obtained in the puddling furnace. The latter weighs only 200 lb., however, being limited in size to the physical ability of the puddler to handle it. Removed from the thimble, the puddle ball is placed in a press, or squeezer, to remove the excess slag and is formed into a compact ingot. The ingot is passed through a blooming mill until it reaches the shears in the form of a bar approximately 200 ft. long by 4 to 8 in. wide and ¾ in. thick.

With the new process it is said that as much wrought iron is produced in 20 min. as can be turned out by two puddlers in a ten-hour day.

Reclaiming Air-Brake Parts

THE illustration shows a tool manufactured by the Foster-Johnson Reamer Company, Elkhart, Ind., for truing and forming radii in emergency valve seats. The tool clamps over the two surfaces of the valve and locates the valve seat squarely and centrally under a forming cutter operated from a squared shank shown at the top of the illustration.



Foster-Johnson tool for reclaiming emergency valve seats

The knurled cap acts as a feed nut during the operation of truing up and forming the radius on the valve seat. An adjustable stop screw is used to prevent cutting below the seat surface. The tool can be gripped in any ordinary vise and is operated with a tap wrench.

A set of Foster-Johnson tools has also been designed for use in straightening emergency valve stems. An accurate grinding device is furnished with the set for truing the gasket with the stem. It is bored to fit the stem closely and can be driven by an air drill or drill press and will grind the gasket flat and square with the stem.

News of the Month

THE DELAWARE, LACKAWANNA & WESTERN will send out inquiries in the near future for about 50 machine tools.

Wage Statistics for December

THE NUMBER of employees reported by Class I railways to the Interstate Commerce Commission as of the middle of the month of December was 1,621,910, and the total compensation was $230,944,242. Compared with the returns for the corresponding month of 1927, the number of employees reported for December, 1928, shows a decrease of 2.31 per cent and the total compensation shows a decrease of 1.94 per cent.

Schmidt-Henschel Locomotive for the L. M. & S.

IT IS REPORTED that the design of a high-pressure locomotive has been started by the London, Midland & Scottish Railway, England. The boiler is a modification of the Schmidt-Henschel high-pressure locomotive boiler and is being designed to suit one of the Royal Scot class of locomotives used by that railroad. The low-pressure section of the boiler will operate at a pressure ot 200 ib. per sq. in. and the high-pressure section at 1,300 lb.

The Royal Scot locomotives are those which are used on the non-stop runs between London, Edinburgh and Glasgow.

Progress of B. & M.- M. I. T. Railway Course

THE PROGRESS of the co-operative course in railroad transportation, conducted by the Massachusetts Institute of Technology and the Boston & Maine, during the first year of its existence was described in an article published in the Tech Engineering News of December, 1928.

This course was designed to dovetail scientific instruction at the school with practical experience on the railway. It extends over five years and leads to a Master's degree. After the first two years, which are spent at the Institute, the students alternate between the school and the Boston & Maine.

Students are registered in the first three years of the course and thus the third year group is now with the B. & M. mechanical department. The work of each student is so scheduled as to permit his participation in all important operations of that department. This is evident from the schedule of one student taken as an example. It calls for: Locomotive shop, four weeks; signal department, two weeks; enginehouse, three weeks; car shop, two weeks; office of the mechanical engineer, three weeks; locomotive operation, three weeks; office of the mechanical superintendent, one week. Upon leaving the mechanical department a similar schedule will be arranged for the students in the maintenance of way and operating departments and in the general offices.

A UNIQUE fire-fighting outfit has been installed by the Anglo-Persian Oil Company on its rail lines. It consists of a truck body, with wheels fitted with flanges for use on rails. It has a capacity for 425 gallons of "Foamite," the solution used in fighting fires. The entire outfit resembles somewhat the large tank trucks used to spread oil on roads. When rushing to the scene of a fire the machine is capable of making over 30 miles per hour.

THE CHESAPEAKE & OHIO plans the expenditure of approximately $3.927,000 in and near Russell, Ky., for the construction of new freight car repair shops, including buildings, power house, machinery, etc., with a capacity for 12,000 freight cars per year. This amount also includes an underpass and run-around tracks under the main tracks in the east end yard to connect yards and round-houses; new yard facilities including new trackage, re-arrangement of switches, installation of car retarders and revision of grades.

THE POST OFFICE DEPARTMENT, Washington, D. C., has prepared a 32-page booklet giving specifications for the construction of steel full and apartment railway post office cars, for fixtures for mail cars, and for the construction of mail apartment self-propelled cars and trailer mail apartment cars operated in connection with self-propelled cars. The first two specifications have been revised to January 2, 1929, and the third was approved on the same date.

FROM COQUITLAM, B. C., near Vancouver, comes the news that 30,000 tons of railroad material—meaning trucks and steel framing for freight cars—will soon be shipped from that point across the Pacific for the Trans-Siberian Railway. This material, it is said, was ordered 13 years ago but, delivery having been prevented by the outbreak of the revolution in Russia, it has been lying in the yard of the Canadian Pacific at Coquitlam all this time.

Clubs and Associations

International Railway Fuel Association

THE INTERNATIONAL RAILWAY FUEL ASSOCIATION will hold its twenty-first annual convention at Chicago on May 7 to 10 inclusive. The program follows:

Tuesday Morning, May 7—Opening Session

Meeting to convene at 11 a.m.
Invocation
President's address.
Address by Sir Henry W. Thornton, president, Canadian National.
Address by R. H. Aishton, president, American Railway Association.
Address by H. L. Gandy, president, National Coal Association.

Tuesday Afternoon—Technical Session

Call to order 2:30 p.m.
Address by A. P. Prendergast, mechanical superintendent, Texas & Pacific.
Paper by L. K. Sillcox, assistant to president, New York Air Brake Company.
Report of Committee on Steam Turbine Locomotives.
Report of Committee on Diesel Locomotives.

Wednesday Morning, May 8—Operating Session

Call to order 9:30 a.m.
Address by Elisha Lee, vice-president, Pennsylvania.
Report of Committee on Front Ends, Grates and Ash Pans.
Report of Committee on Oil Firing Practice.

Wednesday Afternoon

Call to order 2 p.m.
Report of Committee on Coal Firing Practice.

Thursday Morning, May 9—Fuel Handling Session

Call to order 9:30 a.m.
Address by J. B. Hill, president, Nashville, Chattanooga & St. Louis.
Bituminous Coal Conference, report by W. L. Robinson, representative for International Railway Fuel Association.

World Power Conference, report by H. W. Brooks, representative for International Railway Fuel Association.
Report of Committee on Co-operation with Railway Accounting Officers' Association.
Report of Committee on Fuel Distribution and Statistics.

Thursday Afternoon

Call to order 2 p.m.
Report of Committee on Fuel Bulletins.
Report of Committee on Fuel Stations.
Report of Committee on Inspection and Preparation of Coal.

Friday Morning, May 10—Mechanical Session

Call to order 9:30 a.m.
Report of Committee on Coal Fired Power Plants.
Report of Committee on Oil Fired Power Plants.
Report of Committee on New Locomotive Economy Devices.

Business Session

Report of Committee on Constitution and By-Laws.
Election of officers.
Report of secretary-treasurer.
Report of Auditing Committee.

Convention of the Air Brake Association

THE THIRTY-SIXTH annual convention of the Air Brake Association will be held at the Stevens Hotel, Chicago, April 30 and May 1, 2 and 3. The tentative program selected for discussion at this meeting is as follows:

Maintenance of Air Brake Equipment on Gas Rail Cars, by Manhattan Air Brake Club
Report of Committee on Exclusion of Dirt and Moisture from Passenger Brake Cylinders, W. H. Clegg (chief inspector, Canadian National), chairman
Automatic Train Control and Automatic Stop Equipment, by F. H. Nicholson, Union Switch & Signal Company
Car Retarders, by L. Richardson, chief mechanical officer, Boston & Maine
Air Compressor Capacity for Gas-Electric Rail Cars, by M. Purcell (general air brake inspector, Northern Pacific) and C. C. Ferguson (general air brake instructor, Great Northern), North West Air Brake Club
Distributing Valves—Location, Maintenance and Piping, by St. Louis Air Brake Club
Operation and Maintenance of Engineer's Brake Valve, by Central Air Brake Club
Report of Committee on Recommended Practice, H. A. Clark (general air brake inspector, Minneapolis, St. Paul & Sault Ste. Marie), chairman
Report of Committee on What Is the Best Material for Air-Brake and Air-Signal Piping, J. E. Gardiner (general air brake instructor, Boston & Maine), chairman
Report of Committee on Main Reservoirs, W. F. Peck (supervisor air brakes, Baltimore & Ohio), chairman
Slid Flat Wheels in Passenger Train Service—Causes and Remedies, by Pittsburgh Air Brake Club

Present indications point to the largest exhibit of equipment in the history of the Air Brake Association at the Hotel Stevens, Chicago, April 30 to May 3, inclusive, during its 1929 convention. Reports from F. W. Venton, secretary of the Air Brake Appliance Association, indicate that the demand has been so great that it has been necessary to contract for 3,400 sq. ft. of additional space for the exhibit.

Railroad Division, A.S.M.E., Sponsors Trip to Elizabethport

THE RAILROAD DIVISION of the Metropolitan Section of the A. S. M. E., in company with members of the New York Railroad Club and the Manhattan Air Brake Club, will journey on Friday afternoon, April 19, to the shops of the Central of New Jersey at Elizabethport, N. J., where they will be met by representatives of the railroad who will conduct them through the plant and explain the method of handling work in the various departments. The members of the three associations desiring to inspect the shops should take the ferry at the foot of Liberty street, New York, which leaves at 1:45 p. m. This connects with the Central of New Jersey train arriving at Elizabethport at 2:30 p. m. The party will leave Elizabethport at 4:21 p. m.

The New York Railroad Club also extends to the members of the Air Brake Association and the A. S. M. E. an invitation to attend its meeting at the Engineering Societies building, 29 West Thirty-Ninth street, New York, at 8 p. m. on that day, when A. J. County, vice-president of the Pennsylvania Railroad, will speak on the subject of budgeting expenses.

Master Car Builders' Convention

THE NEXT ANNUAL convention of the Master Car Builders' and Supervisors' Association will be held on September 4, 5 and 6 at the Hotel Sherman, Chicago.

The following list gives name of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—T. L. Burton, 165 Broadway, New York. Next meeting, April 30-May 3, 1929, at Stevens Hotel, Chicago.

AMERICAN RAILWAY ASSOCIATION DIVISION V—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Annual meeting June 25-28, 1929, at Alexandria Hotel, Los Angeles, Cal.

DIVISION V—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting, Muehlebach Hotel, Kansas City, Mo., September 10-12.

DIVISION VI—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York. Annual meeting June 24, 25 and 26, 1929, at the Palace Hotel, San Francisco, Cal.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago. Next meeting, September 11-14, 1929, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 7016 Euclid Ave., Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth street, New York. Annual meeting April 24, 25 and 26.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill. Annual meeting Hotel Sherman, Chicago, October 22-25.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charon St., Montreal, Que. Regular meetings, second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que. Next meeting April.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 7836 So. Morgan street, Chicago, Ill. Regular meeting second Monday in each month, except June, July and August, Great Northern Hotel, Chicago. Next meeting April 8. Discussion of recommended changes in the A.R.A. Rules.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—F. G. Wiegman, 720 North Twenty-third street, East St. Louis, Mo. Regular meeting first Tuesday in each month, except June, July and August, at Broadview Hotel, East St. Louis, Ill.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles, Cal. Meetings second Friday of each month in the Pacific Electric Club building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York. Regular meetings second Tuesday each month, except June, July and August, at Hotel Statler, Buffalo. Next meeting April 11 at 8 p. m. Operating night. Entertainment, Erie double sextette of New York.

CHIEF INTERCHANGE CAR INSPECTORS AND CAR FOREMEN'S ASSOCIATION.—See Master Car Builders' and Supervisors' Ass'n.

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 3328 Beekman St., Cincinnati. Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meeting first Monday each month, except July, August and September at Hotel Hollenden, East Sixth and Superior Ave.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next meeting, August 20-22, 1929, Fort Shelby Hotel, Detroit.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—L. G. Plant, Railway Exchange, 80 E. Jackson Boulevard, Chicago. 1929 Annual meeting Hotel Sherman, Chicago, May 7-10, inclusive.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn. Convention September 17-20, inclusive.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3212 Delachaise street, New Orleans, La. Meetings third Thursday in each month.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York. Annual meeting May 21-24, 1929, Hotel Biltmore, Atlanta, Ga.

MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago, Chicago. Annual convention September 4, 5 and 6 at the Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass., Regular meeting second Tuesday in each month, excepting June, July, August and September, Copley-Plaza Hotel, Boston. Next meeting April 9. Paper on Super-Power vs. Redesigned Locomotives for Secondary Service will be presented by W. E. Woodard, vice-president, Lima Locomotive Works.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York. Next meeting April 19. A paper on Budgeting Expenses, will be presented by A. J. County, vice-president, Pennsylvania Railroad. Music by Red Arrow Trio.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings, second Tuesday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR DEPARTMENT OFFICERS' ASSOCIATION.—See Master Car Builders' and Supervisors' Association.

RAILWAY CLUB OF GREENVILLE.—Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meetings third Thursday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205 Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting third Thursday in November, Ansley Hotel, Atlanta, Ga.

SOUTHWEST MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—See Master Car Builders' & Supervisors' Association.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting September 24-28, Hotel Sherman, Chicago.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 189 West Madison St., Chicago. Regular meetings, third Monday in each month, except June, July and August.

Supply Trade Notes

THE STUEBING COWAN COMPANY, Cincinnati, Ohio, has enlarged its Holyoke, Mass., plant to about triple its capacity.

FRANK D. TAYLOR, for many years secretary and director of sales of the Peck, Stow & Wilcox Company, has now become associated with the Trimont Mfg. Company, Inc.

HENRY W. ARMSTRONG, assistant treasurer of the Joseph Dixon Crucible Company, Jersey City, N. J., has been elected treasurer to succeed the late William Koester.

E. W. MCHENRY has been appointed district sales representative at Houston, Texas, of the Reading Iron Company, Reading, Pa.

BENJAMIN A. HEGEMAN, JR., president of the National Railway Appliance Company, New York, died on March 6. Mr. Hegeman was born in New York on July 14, 1860.

EDWIN J. MOHR has been elected president of the Gould Storage Battery Company, Inc., Depew, N. Y., succeeding Kenneth M. Smith, resigned.

GEORGE T. PARASCHOS has been appointed New England representative of the Davis Brake Beam Company, Johnstown, Pa., with headquarters at 1107 Boylston street, Boston, Mass.

THE READING IRON COMPANY, Reading, Pa., has established a new district sales office at New Orleans, La., under the direction of George E. Tyson, 1216 Hibernia Bank building. Mr. Tyson was formerly of the Reading district.

THE GENERAL AMERICAN TANK CAR CORPORATION and the General American Car Company will remove their New York offices from 17 Battery place to the Chanin building, 122 East Forty-second street, New York City.

JOSEPH M. HALL, formerly of the Universal Draft Gear Attachment Company, has been appointed mechanical engineer of the Union Draft Gear Company, with headquarters at Chicago.

H. H. WOOD, formerly chief engineer of the Laclede Steel Company, St. Louis, has joined the industrial department of the Timken Roller Bearing Company, Canton, Ohio. For the present his headquarters will be at Canton.

FRANK C. FARRELL, formerly district manager of the Youngstown Sheet & Tube Company, has been appointed representative of the Steel & Tubes, Inc., division of the Republic Iron & Steel Company.

THE OHIO BRASS COMPANY, Mansfield, Ohio, has opened a new office at 2143 Railway Exchange building, 611 Olive street, St. Louis, Mo. This office will be the headquarters of H. W. Kilkenny, district sales manager for the company in the St. Louis territory.

SKF INDUSTRIES, INC., 40 East Thirty-Fourth street, New York, has moved its Buffalo office from 517 Manufacturers and Traders building to Main and Genesee streets; its Detroit office from 6520 Cass avenue to 2820 East Grand boulevard, and its San Francisco office from 115 New Montgomery street to 221 Eleventh street.

JACKSON BROWN, JR., 701 Kittridge-building, Denver, Colo., is representing the Roller-Smith Company in Colorado, Utah, Wyoming and Northern New Mexico. The Manila Machinery & Supply Company, Incorporated, Manila, Philippine Islands, represents the company in the Philippine Islands.

ADDISON MCGARRETT, formerly with the Niles Tool Works Company, Hamilton, Ohio, is now with the Pratt & Whitney Company, Hartford, Conn., as manager of its new agency sales department. Mr. McGarrett had been with the Niles Tool Works Company for more than 25 years. Robert P. Brinkman, who assisted Mr. McGarrett at Hamilton, is with him at Hartford.

THEODORE FRELINGHUYSEN MERSELES, president of the Johns-Manville Corporation, New York, died suddenly on March 6, while on a visit at Del Monte, Cal. Mr. Merseles was born at Jersey City, N. J., on August 17, 1863, and was educated in the public and private schools. He began work in 1881 as a clerk with the Pennsylvania at Jersey City, and later became a clerk for the Trunk Line Association at New York, where he remained until 1893. He then became manager and vice-president of the Western Wheel Works at Chicago and in 1899 he helped organize the American Bicycle Company of New York and was its vice-president. In 1903 he became vice-president and general manager of the National Cloak & Suit Company, a mail order house, at New York. He left that organization in 1921 to become president of Montgomery Ward & Co., and since June, 1927 he had been president of the Johns-Manville Corporation.

T. F. Merseles

AT A RECENT meeting of the board of directors of the American Steel Foundries, Colonel R. F. Lamont and James F. Curtis resigned as directors and Chauncey Belnap and Thomas Drever were elected to fill the vacancies. Colonel Lamont also resigned as president to become Secretary of Commerce of the United States and George E. Scott, vice-president, was elected president; R. H. Ripley, vice-president, was elected senior vice-president, and Thomas Drever was elected secretary and treasurer.

GEORGE F. JONES has been retired at his own request, after a service of 29 years as head of the Richmond office of the Baldwin Locomotive Works and the Standard Steel Works Company. William B. Keys has been appointed manager and Lewis W. Metzger, Jr., has been appointed assistant manager of the Richmond office for both companies. Mr. Keys has been with the Richmond office for the past 18 years, serving during the past six years as assistant manager. Mr. Metzger has held various positions with these companies for the past 12 years.

CHARLES R. LONG, JR., who has been president of the Viloco Railway Equipment Company, vice-president of the Okadee Company at Chicago, and president of the Viloco Machine Company, Benton Harbor, Mich., has disposed of his entire interests in these companies to Arthur G. Hollingshead, in order to devote his entire time to the Chas. R. Long, Jr., Company, Louisville, Ky., as its president. The Chicago office of the Chas. R. Long, Jr., Company is in charge of Edward S. DePass, vice-president and traffic manager at 1610 Lytton building.

WILLIAM R. SEIGLE, vice-president in charge of mines and factories, has been elected chairman of the board of directors of the Johns-Manville Corporation, and Lewis H. Brown, secretary and assistant to the president, has been elected president. Mr. Seigle succeeds H. E. Manville, resigned, and Mr. Brown succeeds Theodore F. Merseles, who died March 6.

William R. Seigle

William R. Seigle was born at Easton, Pa., in 1879 and has been in the services of Johns - Manville since his graduation from college in 1900, at which time the corporation was known as the H. W. Johns Manufacturing Company. His technical training covered the fields of mechanical and electrical engineering, as well as electro-chemistry. His research and development abilities have been responsible for the development of many of the insulating, electrical and building materials upon which the company has based its substantial success. He has a completely equipped private laboratory at his country home at Mamaroneck, N. Y., where he employs regularly a staff of chemists and in which he spends much of his own time. He is an officer and director in numerous other corporations in the United States and abroad.

Lewis H. Brown

Lewis H. Brown was born in Creston, Iowa, in 1894, and is a graduate of the University of Iowa, where he studied liberal arts and law. After graduation he became a salesman and assistant to the sales manager of a manufacturing company in Indiana. He served two years as a captain of infantry in the 84th division and attached as a staff officer at A. E. F. headquarters in France. Immediately after the war he joined Montgomery Ward & Company, serving in various departments of the business, including such positions as those of office manager, superintendent of merchandise, and assistant general operating manager of all plants. Recognizing Mr. Brown as an executive able to handle difficult organization problems, Mr. Merseles selected Mr. Brown to accompany him as his assistant when he became president of Johns-Manville in August, 1927. Mr. Brown is a member of the board of directors of the Fibre Conduit Corporation and many other companies.

THE AMERICAN HOIST & DERRICK COMPANY, St. Paul, Minn., has appointed F. E. Bauer, Jr., export sales manager with office at 50 Church street, New York. Mr. Bauer has represented the American Hoist & Derrick Company in foreign fields for many years. The company has opened a branch office at 139 Townsend street, San Francisco, Cal., in charge of Boyd Nixon. Arthur Harvey, formerly district engineer of the Missouri-Kansas-Texas at Muskogee, Okla., has been appointed sales representative of the company at Chicago.

Trade Publications

Copies of trade publications described in this column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

THOR ELECTRIC TOOLS.—Catalogue No. 17, issued by the Independent Pneumatic Tool Company, 600 West Jackson boulevard, Chicago, illustrates and gives specifications for numerous Thor universal electric tools, including drills, reamers, screw drivers, tappers, wood borers, grinders, etc.

HANNA RIVETERS.—The Hanna Engineering Works, Chicago, Ill., aims to show in Bulletin R-205-A how Hanna riveters have overcome the faults of earlier types. The bulletin contains 40 pages and is illustrated with an anatomical chart and photographs of various types of Hanna riveters.

TESTING MACHINES.—A historical narrative, written from facts supplied by Frederick A. Riehle, is contained in the 16-page booklet being distributed by the Riehle Bros. Testing Machine Company, 1424 North Ninth street, Philadelphia, Pa. The booklet is entitled "Evolution of the Testing Machine."

UPSET FORGINGS.—National Forging Machine Talk No. 72 issued by the National Machinery Company, Tiffin, Ohio, contains the paper entitled "Some Notes on the Quality of Upset Forgings" prepared by its president, E. R. Frost, for presentation before the Toronto Chapter of the American Society for Steel Treating during October, 1928.

THREADLOCK.—The Dardelet Threadlock Corporation, 120 Broadway, New York, describes in a recent publication the Dardelet patented self-locking bolt which eliminates lockwashers, cotter pins, jam nuts and other devices ordinarily used to keep nuts from loosening. The bolt, known as the Threadlock, is adapted for use wherever equipment encounters vibration or shock.

ROLLER JOURNAL BEARINGS.—The Melcher Spi-Roll railway roller journal bearing, which is exclusively a railroad bearing designed and developed by railway engineers, is fully described and illustrated in publication No. 25 issued by the Railway Motors Corporation, De Pere, Wis. These bearings are interchangeable and are adaptable to all kinds and types of truck and pedestal designs.

PRODUCTION TOOLS.—"Equipment for Automotive and Other High Production Shops" is the title of the attractive 72-page catalogue just issued by the Consolidated Machine Tool Corporation of America, Rochester, N. Y. The catalogue describes a large variety of production tools designed especially to meet mass production requirements of automotive and other industrial shops, but illustrates only those of widest interest. Production data are given where available.

TIMKEN-BEARING APPLICATION.—The Timken Roller Bearing Company, Canton, Ohio, in its latest publication, entitled "Wherever Wheels and Shafts Turn," covers in some detail the general subject of the application of Timken bearings to various types of automotive, railway and industrial equipment. The book, which is attractively bound in blue leather, is divided into eight sections, the eleven pages of Section IV dealing specifically with Timken bearings in railway equipment. The forty-eight pages of Section VIII contain technical information on bearing mountings and installations.

Personal Mention

General

GEORGE CROWDER, who has been appointed superintendent of motive power of the Georgia & Florida, with headquarters at Douglas, Ga., was born in Meriwether County, Georgia. He was educated in the grammar and high schools of that county and later also completed studies in mechanical drawing and air brakes with a correspondence school. In 1901 he entered the employ of the Baldwin Locomotive Works as a machinist apprentice and in 1904, at the conclusion of his apprenticeship, he was appointed track foreman in the erecting shop. He remained with this company until the latter part of 1904, when he resigned to become a machinist with the El Paso & Northeastern, now part of Southern Pacific, at Alamo Gordo, N. M. He returned to Georgia in 1905 as machinist at the Waldo shops of the Seaboard Air Line, in which capacity he remained until the early part of 1907 when he became roundhouse foreman of the Atlantic Coast Line at Jacksonville, Fla. Later in the same year he went to Atlanta, Ga., to enter the service of the Southern. On August 8, 1907, Mr. Crowder was appointed general foreman of the Douglas, Augusta & Gulf (now the Georgia & Florida) at Douglas, Ga., continuing in that position until his recent promotion to the position of superintendent of motive power.

George Crowder

C. M. DARDEN, who has been promoted to assistant superintendent of machinery of the Nashville, Chattanooga & St. Louis, with headquarters at Nashville, Tenn., has been connected with the mechanical department of that railway for 17 years. He spent his boyhood in Richmond, Va., and after attending the Y. M. C. A. night school and the Virginia Mechanics Institute in that city, entered the service of the Richmond Locomotive Works (now part of the American Locomotive Company) as a draftsman in Richmond. Later Mr. Darden was appointed assistant mechanical engineer of the Rogers Locomotive Works at Paterson, N. J., then serving with the Chicago & Alton as mechanical engineer. In 1912 he entered the service of the mechanical department of the Nashville, Chattanooga & St. Louis, at Nashville. At the time of his promotion to assistant superintendent of machinery he held the position of mechanical engineer at Nashville.

C. M. Darden

JOHN PETER LAUX, who has been appointed superintendent of motive power of the Lehigh Valley, with offices at Bethlehem, Pa., was born July 17, 1882, at Pittston, Pa., receiving his education in the high school there, also attending a mechanical school and completing mechanical courses with a correspondence school. He entered the service of the Lehigh Valley on September 10, 1897, at Sayre, Pa., as crew caller, serving with the same road until 1904 as crew dispatcher, machinist apprentice and assistant enginehouse foreman. From 1904 to 1908 he was assistant foreman of the Tennessee Coal & Iron Company at Knoxville, Tenn.; in 1908 became assistant enginehouse foreman of the Southern at Knoxville, and in 1909 became air brake inspector for the New York, New Haven & Hartford, at Hartford, Conn., in the same year returning to the Lehigh Valley as enginehouse foreman at Sayre, Pa. Since that date he has served with the same road consecutively as general foreman at Manchester, Pa., assistant master mechanic at South Easton and master mechanic at Hazleton, master mechanic at Sayre, and master mechanic at South Easton in 1918. In June, 1923, he became superintendent of the system shops of the road at Sayre, Pa., in which capacity he served until his appointment as superintendent of motive power.

Master Mechanics and Road Foremen

DANIEL G. MARTINEZ has been appointed master mechanic of the National of Mexico, with headquarters at Acambaro, Gto.

S. R. MAULDIN, master mechanic on the Illinois Central at Clinton, Ill., has been transferred to Jackson, Tenn., succeeding Lloyd Grimes, deceased.

WALTER R. SEDERQUEST, who has been appointed master mechanic of the New York, New Haven & Hartford, with headquarters at Boston, Mass., was born on March 24, 1888, at Greeley, Colo. He began his railroad career with the Boston & Maine in June, 1903, as a machinist helper, remaining in that position until January 10, 1907, when he entered the employ of the New York, New Haven & Hartford as a mechanic. On December 14 1912, he was promoted to enginehouse foreman at Dover street, Boston; on March 1, 1916, advanced to the position of night general foreman at Cedar Hill, New Haven, Conn.; on October 1, 1918, appointed general foreman at Cedar Hill, and on December 15, 1923, appointed master mechanic of the Old Colony division. Mr. Sederquest's duties now cover the Midland Division.

W. R. Sederquest

MARK JEFFERSON, who has been appointed master mechanic of the Wyoming division of the Lehigh Valley with headquarters at Coxton, Pa., was born on September 20, 1876, at Louisville, Ky. Mr. Jefferson, after completing a grammar school education, entered the service of the Louisville Street Railway in 1889, serving successively electrical and mechanical apprenticeships until 1897. He continued with the Louisville Street Railway as a journeyman until 1898 when he entered the preparatory department of Hiram College. Graduating in 1900, he found employment with the General Electric Company at Schenectady, N. Y., inspecting erection and tests, Marion engines and steam turbines. He again entered Hiram College in 1902, continuing until 1904 when he went to Columbus, Ohio,

to work on electrical maintenance, electrical installation and terminal construction for the Pennsylvania Railroad. He re-entered Hiram College in 1905, completing his course in 1907. His service with the Lehigh Valley began in August, 1907, as assistant erecting foreman at Sayre, Pa. In 1912 he was transferred to the Buffalo Division Terminal as general foreman at Buffalo, N. Y.; in 1913, promoted to the position of assistant master mechanic of the N. J. & L. and N. Y. divisions; in 1916, promoted to master mechanic of the Auburn division, and in 1923, appointed master mechanic of the Seneca division. Mr. Jefferson's recent transfer was from the Seneca division to Coxton.

JOHN BROOKES PORTER, who has been appointed master mechanic of the Old Colony division of the New York, New Haven & Hartford, with headquarters at Taunton, Mass., was born on October 1, 1881, at Wallington, Lancashire, England. He received a grammar school education and on November 1, 1904, was employed by the Louisville & Nashville as a machinist. In July, 1907, he entered the service of the Illinois Central as a machinist at Water Valley, Miss. He left the employ of the Illinois Central in 1910, and in 1911 was engaged by the Missouri Pacific as a machinist at Hoisington, Kans. He was promoted to the position of night enginehouse foreman in 1913 and to day enginehouse foreman in 1914. He resigned from the Missouri Pacific in December, 1917, and in March, 1918, became foreman of the New York, New Haven & Hartford at Providence, R. I. After serving one week in this position, he was promoted to assistant general foreman. In 1920 he was appointed to the position of general foreman which he held at the time of his promotion to master mechanic.

Car Department

W. H. HALL, chief car inspector of the Central Railroad Company of New Jersey, with headquarters at Jersey City, N. J., was retired on pension at his own request on February 1 after having served that road for 34 years. Previous to his employment with the Central of New Jersey, Mr. Hall served on the Pennsylvania for 22 years.

EMMET J. COLE, superintendent of shops of the Union Pacific at Omaha, Neb., since 1925, has been appointed to the newly created position of assistant to the general superintendent of motive power and machinery, with headquarters at Omaha. Mr. Cole, who will devote his attention primarily to shops and enginehouses on the entire Union Pacific system, was born on November 17, 1894 at Cheyenne, Wyo., his education being secured in the public schools of that city. From January 25, 1908, to September 30, 1911, he served as machinist apprentice in the Union Pacific shops at Cheyenne, then working eight months in his father's boiler shop in Cheyenne, three years as machinist for the Big Four at Bellefontaine, Ohio, and for short periods as a machinist for the Cincinnati, Hamilton & Dayton at Lima, Ohio, the Great Northern at Havre, Mont., and the Colorado & Southern at Cheyenne. From March 1, 1918 until June 8, 1919, Mr. Cole served as chief machinist and mate, United States Navy, following which he was employed as a machinist for the Southern Pacific at Portland, Ore., and master mechanic for the Deer Island Logging Company at Deer Island, Ore. On July 16, 1921, he returned to the service of the Union Pacific as a machinist at Cheyenne, becoming erecting gang foreman at the same point August 1, 1921; district foreman, May 1, 1922; superintendent of shops, September 15, 1923; and superintendent of shops at Omaha, Neb., August 1, 1925.

E. J. Cole

Purchases and Stores

ROBERT H. ADAMS, assistant purchasing agent of the Los Angeles & Salt Lake, has been promoted to purchasing agent, with headquarters at Los Angeles, Cal., succeeding N. H. Foster, deceased.

ROBERT H. ADAMS has been promoted to purchasing agent of the Los Angeles & Salt Lake, with headquarters at Los Angeles, Cal. Mr. Adams has been connected with the L. A. & St. L. for more than 28 years.

CHARLES R. PEDDLE, assistant purchasing agent of the Pennsylvania, with headquarters at St. Louis, Mo., retired on January 1. Mr. Peddle had been in railway service for more than 51 years.

Obituary

ROBERT LEE BAUGH, former purchasing agent of the Central of Georgia, died at the home of his son in Memphis, Tenn., on February 5 at the age of 80 years.

W. H. DYER, superintendent of motive power of the Georgia & Florida, with headquarters at Douglas, Ga., died at his home in that city on January 8 from a heart attack.

HOWARD STILLMAN, mechanical engineer and engineer of tests of the Southern Pacific from 1893 to 1924, died at his home at Berkeley, Cal., on February 7, at the age of 73 years.

EDWARD THOMAS STONE, purchasing agent of the Minneapolis, St. Paul & Sault Ste. Marie and the Duluth, South Shore & Atlantic, died at Minneapolis, Minn., on December 22.

MICHAEL J. DRURY, former mechanical superintendent and superintendent of shops of the Atchison, Topeka & Santa Fe, died from heart disease at his home at Topeka, Kan., on January 29, after a two weeks' illness. Mr. Drury had been in railway service for 59 years, nearly 40 of which were spent on the Santa Fe. He was born at Birkenhead, England, on May 24, 1849, and attended public school at Parkersburg, W. Va., and Louisville, Ky. From 1866 to 1870 he served an apprenticeship as a machinist at Parkersburg, then entering railroad service on January 1 of the latter year as a machinist on the Baltimore & Ohio at Grafton, W. Va. From 1876 to 1889 he was successively a machinist on the B. & O. at Chicago Junction, Ohio, machinist, gang foreman and machine shop foreman on the Missouri-Kansas-Texas at Parsons, Kan., machinist on the Lake Shore & Michigan Southern (now part of the New York Central) at Elkhart, Ind., night foreman on the Fort Worth & Denver City at Fort Worth, Tex., and machinist on the Denver & Rio Grande at Denver, Colo., Pueblo and Salida. Mr. Drury then became a machinist and gang foreman on the Santa Fe at Topeka and for the following 13 years was successively general foreman at La Junta, Colo., and Arkansas City, Kan., and division foreman at Arkansas City. In September, 1902 he was advanced to master mechanic of the First and Second districts of the Albuquerque division at Winslow, Ariz., where he remained until May, 1906, when he was transferred to the New Mexico and Rio Grande divisions at Raton, N. M. In November of the latter year he was promoted to mechanical superintendent of the Western lines of the Santa Fe, with headquarters at La Junta, and in May, 1912, he was appointed superintendent of shops at Topeka. Since 1923 Mr. Drury had been a system mechanical inspector.